Assessing Activeness in Response to the Addition of a Playground Animator at an Indigenous Elementary School with the Kahnawake Schools Diabetes Prevention Project

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PA- Physical Activity

PE- Physical Education

T2DM- Type 2 Diabetes Mellitus

ROS- Reactive oxygen species

MET- Metabolic equivalent

VO2 MAX- Maximum oxygen consumption during exercise

GLUT 4- Glucose transporter protein

CRP- C reactive protein

IL-6- Interleukin 6

PUFA- Poly-unsaturated fatty acids

ER- endoplasmic reticulum

ATP- Adenosine tri phosphate

MODY- Mature onset of diabetes in youth

KSDPP-Kahnawake Schools Diabetes Prevention Project

HDL- High density lipoprotein

FABP2-Fatty acid binding protein

WHO-World Health Organization

SES-Socioeconomic status

MVPA-Moderate to vigorous physical activity

BMI-Body mass index

SOPLAY- System of observing play and leisure time activity in youth

DPAS – Global strategy on diet physical activity and health

NCD-Non communicable diseases

CDC- Centers for disease control

CCHS-Canadian community health survey

HBA1C- Glycosylated hemoglobin

DNA- Deoxyribonucleic acid

CAB- Community advisory board

RT- Research team

Abstract

Background: T2DM (Type 2 Diabetes) has relatively recently emerged as new epidemic now affecting children. T2DM also disproportionately affects Canadian First Nations and Inuit. Physical activity during childhood has been shown to reduce the likelihood of the progression to overweight and obesity in adulthood. Overweight and obesity are predictors of the onset of T2DM. ***Objective:*** To describe and assess activity levels of schoolchildren in an indigenous elementary school with and without the presence of a playground animator in order to further enhance knowledge and prevent T2DM in this population. The proportions of students in sedentary, active, and walking (moderate) physical activity levels were described with and without the presence of a playground animator. The relationship of physical activity to contextual variables such as supervision, organization and equipment were also described. The effect of temperature and time were also observed for their effects on physical activity level. In order to address other issues affecting healthy lifestyles, we also examined negative behaviours such as bullying or teasing (name calling) and used field notes to provide an ethnographic description of the playground atmosphere. ***Methods:*** A direct observation method entitled SOPLAY was used to assess physical activity and record other contextual variables. Children in grades 1-6 were observed during three months (September to December 2011) at recess and lunchtime when an intervention in the community offered an animator at the school on alternate days for recess and lunch time. ***Results:*** After 3 months of observations the average number of children per scan observed engaging in sedentary activity was 0.49 ± 1.21, for walking activity 7.22 ± 6.96, and for active 2.94 ± 4.38. A comparison of days with and without the animator showed no differences in activity level overall. The contextual variables (organisation, equipment provision and supervision) were found to be significantly positively associated with walking and active (MVPA) behaviours ($p<0.05$) but not with sedentary activity. Temperature change (-4°C to 25°C) showed significant correlations

with activity levels ($p<0.05$), higher temperatures were found to be positively associated with increases in sedentary and active levels. Poor snack choices and peer teasing and bullying were observed in the school's environment as well. ***Conclusions:*** Improving physical activity levels, and healthy lifestyles among children in schools as a group poses special obstacles and numerous resources are needed to effect change. More research involving the critical examination of the most promising behaviour change techniques with school children is needed. Barriers to successful implementation of school based physical activity and healthy behaviour interventions require in-depth policy guidance.

Abstrait

Contexte: DT2 (diabète de type 2) a relativement récemment émergé comme une nouvelle épidémie qui affecte maintenant les enfants. DT2 affecte aussi les Premières nations du Canada et les Inuits de façon disproportionnée. L'activité physique pendant l'enfance a prouvé réduire le risque de la progression de la adiposité et l'obésité à l'âge adulte. L'adiposité et l'obésité sont des facteurs prédictifs de diabète de type 2. ***Objectif:*** décrire les niveaux d'activité des enfants d'école, dans une école élémentaire indigènes, afin d'améliorer les connaissances sur le DT2 et de prévenir le DT2 dans cette population. Les proportions d'étudiants qui mènent une vie sédentaire, active (intensité modérée à vigoureuse) et les niveaux d'activité physique de marche ont été décrits. La relation entre l'activité physique à des variables contextuelles telles que la supervision, l'organisation et l'équipement qui ont également été décrits. La température et le temps font effet et ont également été observées pour leurs effets sur le niveau d'activité physique. Afin de répondre à d'autres questions qui touchent les changements de mode de vie sain, nous avons également examiné les comportements négatifs tels que l'intimidation et les taquineries (insultes) et des notes de terrain utilisé pour fournir une description ethnographique de l'atmosphère des aires de jeux. ***Méthodes:*** Une méthode d'observation directe qui se nomme SOPLAY a été utilisée pour évaluer l'activité physique et pour enregistrer d'autres variables contextuelles. Les enfants aux niveaux primaires (1-6) ont été observés pendant trois mois (Septembre à Décembre 2011) à la récréation et pendant l'heure du dîner quand un appui communautaire a offert un animateur à l'école tous les deux jours ou le pendant le temps de la récréation et du dîner. ***Résultats:*** Après 3 mois d'observations, le nombre moyen d'enfants par observation qui participe à une activité sédentaire était de 0,49 + / - 1,21 ; 7,22 + / - 6,96 pour une activité de marche et 2,94 + / - 4,38 pour actif. Les variables contextuelles (organisation, la fourniture d'équipements et de supervision) se sont avérés significativement et positivement associée à la marche et aux

comportements actifs ($p<0,05$), mais pas avec l'activité sédentaire. Changement de température (-4ºC à 25ºC) démontre des corrélations significatives avec les niveaux d'activité ($p<0,05$), la température qui augmente graduellement se révèle être positivement associée à l'augmentation des niveaux sédentaires et actives. Les niveaux d'activité de marche augmentent avec la température plus fraîche. L'addition d'un animateur de jeux a démontré une corrélation positive avec la marche qui augmente au fil du temps ($r=0,26$, $p<0,0001$). ***Conclusions:*** Améliorer les niveaux d'activité physique et le mode de vie sain chez les enfants dans les écoles comme un groupe pose des obstacles spéciaux et de nombreuses ressources sont nécessaires pour effectuer un changement. Il faut davantage de recherches portant sur l'examen critique des techniques de changement comportement plus prometteurs avec les élèves. Obstacles à la mise en œuvre réussie de l'école selon l'activité physique et un comportement sain interventions nécessitent des orientations détaillées.

Introduction

Type 2 Diabetes

Type 2 diabetes is an increasing health burden worldwide and is characterised by insulin resistance (unable to respond to insulin) and, or the inability for the body to produce sufficient insulin resulting in glucose intolerance and elevated blood glucose levels (Ayach and Korda 2010). Complications of Type 2 diabetes include retinopathy (leading to blindness), neuropathy (resulting in nerve damage), nephropathy (renal damage), hypertension, macro vascular complications (coronary heart disease, stroke and peripheral vascular disease leading to leg amputations), skin disorders (impaired wound healing and increased infections). It is the macro vascular complications which are ultimately responsible for most deaths due to Type 2 diabetes(LeRoith Derek, Taylor et al. 2004). Type 2 diabetes is distinguished from Type 1 diabetes by the fact that Type 1 cases of diabetes do not produce insulin at all. In most cases, Type 2 diabetes is associated with obesity and the predominant risk factors include abdominal obesity, obesity and other factors such as diet and lifestyle (low fiber, inadequate intake of fruits and vegetables, high in saturated and trans fat and high intake of red meat, smoking and low levels of physical activity) (Joost 2008). Post natal nutrition that relies on bottle (formula) feeding or mixed feeding is also a risk factor for type 2 diabetes due to subsequent unfavorable weight gain as well as maternal prenatal nutrition and health status (McMillen, Rattanatray et al. 2009). The biochemical markers used to assess risk are fasting and post prandial blood glucose levels and HbA1C. The risk for type 2 diabetes is also much higher in obese children (Joost 2008) (Gropper 2005).

Pathogenesis of T2DM

The pathogenesis of T2DM is multifactorial and includes pathophysiological occurrences such as the increase in adipose tissue size and then a limited availability for storage results in “ectopic” or an abundance of free

or non-stored triglycerides and fatty acids. A down regulation of glucose transporter GLUT 4 is seen in skeletal muscle (decreased vesicle translocation) and is also reduced at the mRNA level in adipocytes of obese individuals. Reduced glucose transporters result in increased blood glucose. It is suggested ectopic fats cause steatohepatitis (in liver) and insulin resistance in muscle (essentially insulin resistance in muscle and liver) via the decrease in GLUT 4. The mechanism could be attributed to possibly an endocrine disruption due to abnormal insulin levels or a down regulation of the signaling pathway or a mutation already existing or perhaps the accumulation of fat results in pathway disruption(Holt 2011).

Pancreatic B-cell (insulin secreting cells) will eventually lose their function due to apoptosis. Apoptosis is described as cell death and is thought to be caused by a combination of lipotoxicity and glucotoxicity. Inflammatory cytokines may also play a role in the pathogenesis of type 2 diabetes as a result of the inflammation of adipose tissue due to obesity. These biomarkers include Il-6 and CRP (C-reactive protein), however are included in the pathogenesis to a lesser extent.

Adipose tissue has been demonstrated to function as a signalling mechanism to produce IL-6 in order to stimulate CRP production in the liver. This inflammatory pathway is shown to be causal in the mechanism leading to T2DM and other diseases such as metabolic syndrome and cardiovascular disease. An inverse association has been demonstrated in several epidemiological and cohort studies between physical activity and physical fitness with systemic inflammation marked by CRP (Lavie, Church et al. 2011).

Some genetic sequences have been elucidated to be associated with higher and lower risks but are not widely accepted as causal (Gropper 2005; Joost 2008). In essence the abnormal insulin signalling in overweight or obese or metabolically obese individuals is thought to disrupt insulin signalling pathways to induce insulin resistance. And then excess lipids and/or elevated blood glucose

will eventually cause beta-cell dysfunction and lead to insulin dependence (decreased output of insulin) or insulin resistance characterised by T2DM.

B-cell Apoptosis and Reactive Oxygen Species (ROS)

Apoptosis is derived from the Latin term "programmed cell death" which essentially means the gradual destruction of a cell. ROS are highly destructive to human cells (causing apoptosis) and are implicated in many diseases such as T2DM. ROS occur as many different forms such as superoxides, hydrogen peroxides, and lipid peroxides. Factors such as hormones (epinephrine and dopamine), nutrients such as folate (in the form of tetrahydrofolate), free iron, radiation, gamma rays, and ischemia promote free radical formation which leads to cellular damage. However it is also known that antioxidants play an important role in the neutralization of free radicals. Common antioxidants include Vitamin C (ascorbic acid) and Vitamin E (tocopherol) (Elsner, Gehrmann et al. 2011).

Beta-cell apoptosis and loss of function in T2DM has been attributed to the beta-oxidation of lipids (long chain) to form hydrogen peroxide (ROS) in the mitochondria resulting in lipotoxicity. Lipotoxicity due to excess lipids of the b-cell and destruction of the cell are caused by the inability to sufficiently neutralize these species. ROS have been implicated in many diseases due to their ability to attack DNA, proteins and PUFA's. It has been elucidated that it is long chain fatty acids (>20carbons including fatty acids such as eicosapentanoic acid and decosapentanoic acid) which have to be oxidised in the peroxisome region of the cell and results in ROS (H2O2) end products (Gropper 2005; Elsner, Gehrmann et al. 2011) .

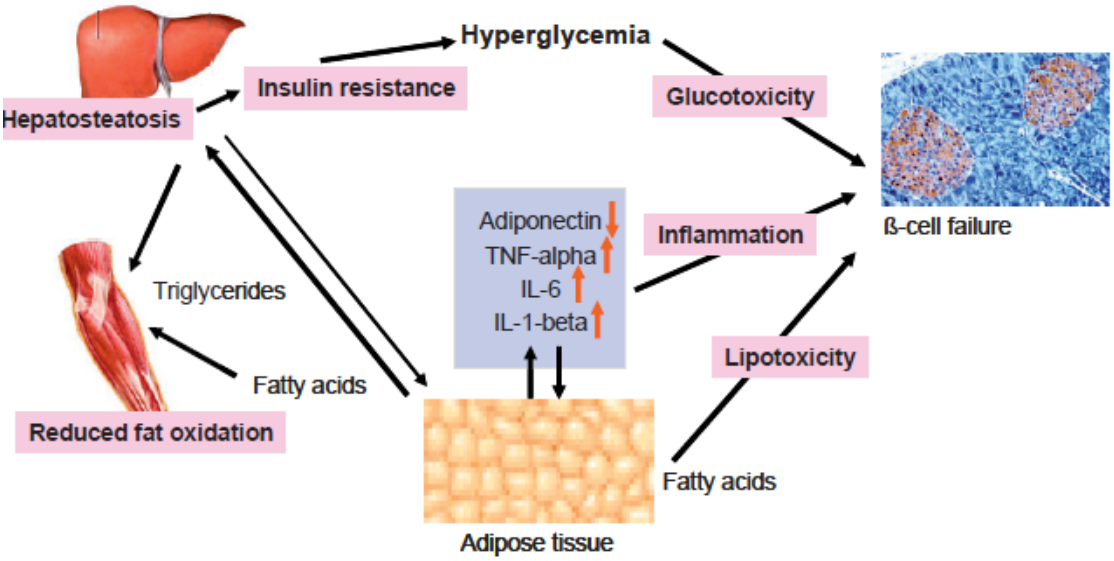
Glucotoxicity and Lipotoxicity

Constant emerging experimental research shows that a possible mechanism for the glucotoxicity of b-cells is ER disruption. Hyperglycemia has been shown to disrupt the cell ER (endoplasmic reticulum) which is a cell

structure responsible for post transcriptional processes of protein formation. ER stress has been shown to disrupt endocrine factors, and also ultimately contribute to cell death. Some evidence suggests glucotoxicity and lipotoxicity (the formation of ROS from excess lipids) must occur together for the cell death to occur and that the mechanisms are quite different for both and this makes finding treatment for both quite multidimensional. Experimental studies have used antioxidant therapies; however they do not completely halt b-cell destruction which implicated ER distress as a main mechanism aside from ROS. Other possible mechanisms for b-cell apoptosis include the production of ceramide, and nitric oxide (Poitout and Robertson 2008; Molina, Wikstrom et al. 2009; Karunakaran, Kim et al. 2012).

In long term aerobic training an individual will adapt to an altered metabolism during exercise, primarily a greater utilization of fat rather than carbohydrate. Long chain fatty acids are a preferred fuel source for individuals involved in mild to moderate intensity aerobic (requiring oxygen) activity such as walking, jogging, playing sports etc. for non- endurance lengths (ADA 2009).

Figure 1: Pathogenesis of Type 2 Diabetes(Joost 2008) Joost et al.



Insulin Sensitivity

Insulin sensitivity is the impaired secretion of insulin by the pancreas or the inability to efficiently use insulin to regulate blood glucose. Insulin sensitivity is caused by factors stated in the preceding section.

If insulin sensitivity is compromised, the individual will compensate through increased insulin output which will accommodate the individual (Gungor, Hannon et al. 2005). Insulin resistant individuals should be treated with lifestyle interventions to reduce the likelihood of progressing to T2DM. Insulin resistance results in impaired glucose tolerance and a raised blood glucose level. It is this biochemical measure that will signal a disruption in normal metabolism and indicate to the health professional the need for intervention (Holt 2011). Regular exercise training has been shown to reduce adiposity and improve insulin sensitivity thereby reducing the risk of T2DM (Lavie, Church et al. 2011).

A family history of T2DM may pass down an insulin resistant trait onto future generations and give these individuals an increased susceptibility to T2DM. This occurrence gives further evidence to the gene theory in the pathogenesis of diabetes; an individual has yet to acquire T2DM yet environmental interactions and genetic abnormalities will combine to induce the disease. Intrauterine nutrition (under or over nutrition) is also associated with post natal glucose intolerance (Pratley 1998) .

Fetal and Infant Nutrition

Several studies of large populations have demonstrated the important link between maternal nutrient supply and fetal nutrient supply with risk of obesity and glucose intolerance later in life for the infant. Galtiere et al reported that incidences of gestational diabetes mellitus (GDM), essentially diabetes of pregnant women, is 1.8 to 6 times higher in overweight women and 1.4 to 20 times higher in women who are obese. Regardless of having a diagnosis of GDM, an overweight or obese pre pregnancy weight is associated with having an infant who is large for gestational age. In fact Brown et al found that for each 0.1 unit increase in pregravid waist to hip ratio , there was a predicted 120g increase in birth weight, 0.51cm increase in length and a 0.3 cm greater head circumference (Galtier-Dereure, Boegner et al. 2000). Oken and Gillman reported that there is a 0.5 to 0.7 kg/meter squared increase in BMI (Body mass index) for each increase of 1kg at birth weight for subsequent childhood and adult years. Body mass index is the ratio of weight (kg) over height in meters squared.

High maternal nutritional consumption (a higher energy consumption compared to control subjects) and maternal fat mass have been shown to impact fetal growth and increase the risk of having a macrosomic infant. A “J” or “U” shaped relationship exists between birth weight and risks of adult obesity; very low birth weight and high birth weight babies are at an increased risk of having weight problems as adults (Biri, Korucuoglu et al. 2009; McMillen, Rattanatray et al. 2009).

If maternal gestational diabetes mellitus is present, the developing fetus experiences hyperinsulinemia, fetal overgrowth, increased fetal adiposity and hyperleptinaemia. The lack of maternal insulin passage to the developing fetus causes the adverse carbohydrate metabolism such as hyperinsulinemia and subsequent outcomes such as increased fat mass if left untreated in the prenatal state (Emily and Matthew 2003) (McMillen, Rattanatray et al. 2009). Stuebe et al discovered that for every 5 unit increase in body mass index; the risk of having a large for gestational age infant was increased 1.21 times (Stuebe, Landon et al. 2012).

Furthermore, the hormonal and neuroendocrine networks of babies exposed to maternal over nutrition have been shown to have been altered prenatally in experimental animal studies. More specifically they have found that maternal nutrition and over nutrition alters an infant's neuronal appetite regulation networks through the over or under expression of orexigenic (appetite stimulating) and anorexogenic (appetite inhibiting) hormones through increased fat deposition in infancy and in utero and favors a lipogenic phenotype which may predict adult onset of T2DM or obesity and overweight(Muhlhausler, Adam et al. 2006), (McMillen, Rattanatray et al. 2009). These links suggest there is an intergenerational cycle of obesity caused by influences of maternal nutrition on the developing adipocyte and brain of the fetus.

Dabelea et al. compared the BMI of siblings from a Pima community in central Arizona who were exposed and not exposed gestational diabetes mellitus in utero. It was found that siblings exposed to GDM had a higher BMI at ages 9-24 compared to their siblings who were not exposed to GDM. They were also 3.7 times more likely to have a diagnosis of T2DM as well (Dabelea, Hanson et al. 2000).

Type 2 Diabetes- Indigenous Population

The World Health Organization estimated the global prevalence of diabetes to be 347 million. Approximately 285 million people worldwide have T2DM.

Diabetes prevalence does differ across racial and ethnic groups and the Canadian First Nations population and Inuit populations have 5 fold higher prevalence which varies between 8% and 48% across genders and different tribes of First Nations people and Inuit (Ayach and Korda 2010). In the community of Kahnawake, where this project takes place, it was found that in 2003 the prevalence of T2DM was 8.4% in males and 7.1% in females and has increased since 1986. And prevalence rates were found to be highest among the age group of 45-64 years of age with 14.8% of men and 11.2% of women having T2DM in 2003 (Horn, Jacobs-Whyte et al. 2007).

Genetic Role in Type 2 Diabetes and in Obesity

Not one gene has been identified to be causal in the pathogenesis of T2DM or obesity in its mutation or variation. In an effort to treat obesity and T2DM many researchers have used the candidate approach to look at genes responsible for these conditions. The candidate approach involves the usage of theories of human systems to identify a possible gene which codes for the functioning of those systems. Several genes have been identified such as the leptin gene (for appetite regulation and energy expenditure in response to adipocyte concentration) in obese subjects. There have been numerous genes studied for their role in T2DM in US Indigenous populations as well as First Nations of Canada and some have been shown to positively associate with T2DM in certain populations and are discussed in the following section. It is important to note however that T2DM still exists very widely even in the absence of some of the genes identified (Andersen 2003).

First or Second Degree Relatives

Many studies have shown that having first or second degree relatives with low insulin sensitivity increases susceptibility to T2DM. In one study which compared the insulin sensitivity of African American children with a family history of T2DM with matched controls without a history found those with a family history to be more insulin resistant, however when controlling for percent body fat, 65% of the variance was related to their level of body fat (Danadian, Balasekaran et al. 1999). These findings continually suggest the etiology is multifactorial and that body fat and other environmental factors contribute to insulin sensitivity however first or second degree relatives do associate with offspring risk of T2DM, and this also contributes to the gene theory of T2DM.

HNFF1A gene

As stated, genes have been studied for their association to T2DM in various populations such as Canadian First Nations and Europeans usually through the candidate gene approach. The studies found several associations and include many different genes such as HNF1A which encodes for a hepatic nuclear factor (HNF 1 α) which regulates b-cell function. HNF1A was found to be associated with T2DM in large studies (Europe) and also in a Canadian First Nations study. HNF1A was a candidate gene due to its association with MODY; mature onset of diabetes in youth is an inherited form of diabetes and differs from T2DM. One study included 540 participants who were tested for the HNF1A variant G319S. After a 10 year follow up period there was significant odds ratio of 3.78 (95% CI 2.13-6.69) for the genetic variant after adjusting for age, sex, hypertension, triglyceride, HDL cholesterol, and waist circumference. It was discovered that when stratifying for smoking the odds ratio increased to 6.91 (95%CI 3.38-14.12) and the association was not- significant among non- smokers (1.11 (0.4-3.08)) (Ley, Hegele et al. 2011). The figure represents these findings. Smoking was considered to have toxic effects on pancreatic b-cells. These “gene environment interactions” are a possible mechanism in the pathogenesis of T2DM.

Figure 2: HNF1A G319S Variant and incident T2DM (Ley, Hegele et al. 2011) Ley et al.

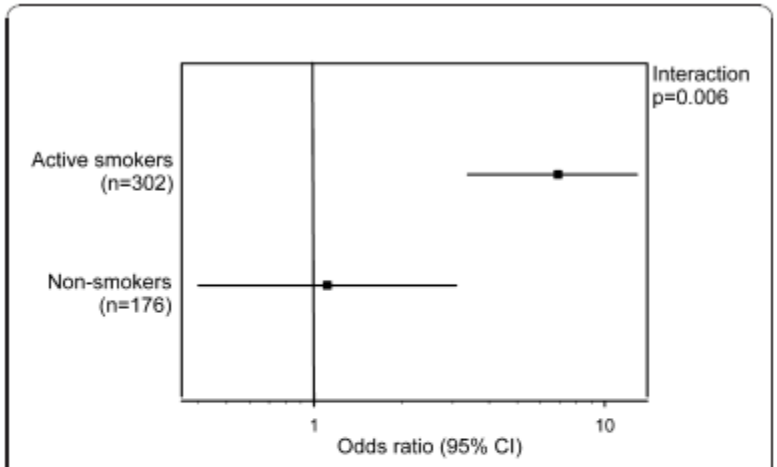


Figure 1 *HNF1A* G319S and incident type 2 diabetes stratified by active cigarette smoking. Odds ratios are adjusted for age, sex, hypertension, triglyceride, and waist circumference. The distributions of S319 carriers within smokers and non-smokers were 55/303 (18.2%) and 38/176 (21.6%) and were not statistically different (p = 0.36).

Pima Population and T2DM in Children

The Pima are an indigenous population which historically were living in Arizona, United States and still reside there presently as well. Their importance to the area of study of T2DM is due to their high prevalence of this disease and the discovery of this disease with children in the population as well.

It has been reported that it was not until 6 obese Pima Indian children with a strong familial history of T2DM were diagnosed with T2DM in the 1980's that the disease seemed to have then also emerged in populations around the world among children (Gungor, Hannon et al. 2005). T2DM in children emerged as a new epidemic in the 1990's in Canadian Aboriginal (First Nations, Metis, Inuit) populations as well. T2DM affected Canadian Aboriginal populations to the extent that in the central Canadian region of Manitoba and Northwestern Ontario

it was observed that almost all child T2DM cases occurred in Aboriginal children. The incidences of cases of T2DM increased substantially to consider this as a new diseases and not simply a rare occurrence of diabetes in children. In Manitoba alone incidence increased from 1-2 cases per year to 20 cases in 1998. Strong familial heritability, a BMI in the greater 85th percentile and ethnicity are strong predictors in the description of this new epidemic. Barriers in the maintenance a healthy lifestyle in Aboriginal communities include being in a remote location (northern communities), the high cost of food, the monopoly of food supply in the north, a short growing season for fresh garden fruits and vegetables in the north, the reliance on local water transportation, frigid outside temperatures, unpaved roads that are unreliable for walking due to dust , the wildlife affecting personal safety, the lack of running water, the limited organization of recreational physical activity (especially in female teens) and the lack of adult role models (Dean 2001).

The interesting link in familial histories in the Pima population has likely been the reason many genes of the Pima Indian population have been studied in order to find their association with T2DM and to make causal associations between genes and T2DM. Initially, environmental factors were found to be causal in the pathogenesis of T2DM in this population due to the evidence that groups of Pima Indians migrated to Maycoba, Mexico 700-1000 years ago and do not suffer from T2DM to the same extent as American Pima. Mexican Pima Indians have higher physical activity levels and a traditional Pima diet low in saturated fat. Despite this strong environmental influence, genetic influences were studied in the American Pima due to the very high prevalence compared to other neighbouring regions in the U.S such as the population of Arizona. More specifically the FABP2 gene which encodes the intestinal fatty acid binding protein was found to be linked to diabetes through its polymorphism or different gene structure which suggests this protein differentiation leads to a different metabolic consequence, more specifically insulin resistance due to a threonine substitution rather than alanine in the codon 54 (Pratley 1998) . This genetic difference results in metabolic changes such as increased binding of long chain

fatty acids with the threonine substitution and altered rates of appearance in plasma which can affect insulin levels. However this genetic difference does not cause T2DM , and may only alter the physiology of an individual to increase their risk, however the fundamental mechanisms in the pathophysiology of T2DM remains the same and most scientists suggest that it is gene-environment interactions which result in many cases of T2DM (Pratley 1998).

Obesity, Type 2 Diabetes and Children

As stated earlier, T2DM has emerged relatively recently as a disease which also affects children as well. Native American, First Nations and Inuit children and other ethnic groups such as Mexican American, and African American are considered to be a high risk group, however, it has been reported that pediatric centers worldwide are experiencing an increase in T2DM. Children also suffer other forms of diabetes including MODY (mature onset diabetes in youth) and atypical diabetes. However the pathophysiologies of the different forms differ. For example MODY is an inherited type of diabetes which affects mainly Caucasians and is not associated with obesity or insulin sensitivity. Atypical diabetes affects Asians and African Americans to a greater extent and is also an inherited disease without insulin sensitivity and the association of obesity with the disease varies in individuals affected with the atypical form.

Risk factors seen in children include, race and ethnicity (Pacific Islander, African American, Hispanic, Native American, Canadian First Nation) , insulin resistance, a family history of type 2 diabetes, intrauterine growth restriction, maternal gestational diabetes, insulin resistance, lack of physical activity, and a high calorie diet. Some studies have shown that certain populations and individuals with a family history of T2DM have decreased insulin sensitivity which predisposes them to T2DM even though they are of normal weight and are not obese (Botero and Wolfsdorf 2005). This may also be the cause of T2DM in a non-obese phenotype often reported as the “normal weight metabolically obese

phenotype" that has an increased abdominal obesity and less muscle mass (Hu 2011).

Overweight and obesity in children precede many health problems which will occur later in life. It is shown that overweight and obese children are at elevated risk of hyperlipidemia, hypertension, abnormal glucose tolerance and Type 2 diabetes. These health consequences in childhood are predictive of adult onset of many diseases such as heart diseases and complications of diabetes at a younger age. This increasing trend is also attributed to sedentary lifestyle, decreased level of physical activity, and an increased energy content of the diet (Summerbell 2005).

Nutritional Factors Associated with Diabetes

The principal nutritional factor associated with diabetes is excess energy intake. In addition many specific nutrients and or food factors have been implicated in T2DM, such as sugar sweetened beverages which have a high level of sugar and can lead to adiposity increases, and raise blood glucose levels. Diets high in saturated fats, and diets low in fiber containing very little fruits and vegetables are likely causal in T2DM (Gropper 2005). High glycemic index foods are generally less nutritious than low glycemic index foods. The glycemic index is rated on a scale with the highest level being that of sugar (white granulated). The food reference for the level of the glycemic scale is white flour (Garrett and Philmore 2003). High glycemic index foods have the ability to raise one's blood glucose sharply and thus are implicated in T2DM (Gropper 2005) .

Physical Activity and Type 2 Diabetes

Physical activity is a common method to decrease the amount stored adipose tissue, and is a therapeutic method, with diet changes used to decrease the risk of an individual's progression to T2DM and to reduce an individual's risk of the disease.

At a metabolic level, short bursts of activity which last no longer than a couple of seconds (i.e. weight lifting and quick movements in basketball) use the

phosphagen anaerobic pathway and use ATP and creatine phosphate as sources of energy from skeletal muscle. These sources, however, are only available for 3 to 5 minutes. In addition, exercises such as short sprints lasting 1 to 3 minutes use a glycolytic pathway with glucose and glycogen as the primary fuel source. After 5 minutes neither the phosphagen nor glycolytic anaerobic pathways are sufficient to maintain a high level of muscle contraction. Exercise lasting greater than 5 minutes such as running will use an oxidative pathway which uses muscle and liver glycogen as well as intramuscular blood and adipose tissue triglycerides. As more oxygen is made available the body will rely on the oxidative pathway for energy (ADA 2009).

Exercise, $V0_2$ max and Energy Expenditure

During light exercise such as walking or at 24%-30% of one's $V0_2$ max, (VO_2 max is defined as the point at which an increase in exercise intensity no longer results in an increase in oxygen consumption) the oxidation of free fatty acids derived from muscle triglycerides provide the required energy to complete the exercise.

Moderate intensity short term exercise (going for a longer walk, or doing housework at 65%VO_2 max) also uses muscle triacylglycerides in the provision of energy. In the range of extreme exertion or at long term periods of moderate to intense activities such as running or 60-75% of one's VO_2 max., free fatty acids are not oxidized rapidly therefore carbohydrates are required for energy (Gropper 2005).

In relation to T2DM excessive sedentary behaviour such as sitting and lying is associated with a much higher risk of cardio metabolic diseases such as type 2 diabetes and explains much of why physically inactive individuals are susceptible to T2DM (Swartz, Squires et al. 2011).

The Kahnawake Schools Diabetes Prevention Project and Project Playground

Created in 1994 in response to community concern about the high prevalence of T2DM in the Mohawk community of Kahnawake, KSDPP was created as a community-university partnership to design community interventions aimed at preventing this disease and raising community awareness and mobilisation around T2DM and its causes (Montour, Macaulay et al. 1989). Community physicians pioneered the project and it now continues to function as a participatory research project in Kahnawake comprised of community individuals and academic researchers. Examples of interventions targeting physical activity include activities and events in the schools supported by interventions in the entire community: involvement of elementary children in various community walks, a bowling party for children a Health Education Curriculum that addresses healthy lifestyles and lobbying for diabetes prevention in the school curriculum, as well snow sculpture contests, encouragement to elementary school teachers and prize events for participation in physical activity etc. (Levesque 2005) (Macaulay and Paradis 1997).

KSDPP also encourages healthy eating, a positive attitude, and physically active lifestyles. Healthy knowledge in schools is increased though a health curriculum and a new physical activity policy. Supportive ecological environments include, new recreation paths constructed, the provision of healthier snacks in schools and clubs, and also school based physical activity interventions.

Literature Review

Energy Expenditure

The endocrine hormone insulin is secreted by the pancreatic beta-cells in the Islet of Langerhans region of the pancreas in response to a meal or food in the stomach. Insulin is a fed (absorptive) state hormone and is responsible for anabolism and storage of the macronutrients protein, fat and carbohydrate (more

particularly glucose). In the fed state the circulating mono-glyceride and free fatty acids in the body are converted back into triglycerides for storage into the adipose tissue for use when needed for energy transformation. Lipids are used as a primary fuel source in the fasting state (3-18 hours post meal) when glucose sparring occurs due to its role as a sole energy source for the brain. Fuel utilization of fatty acids occurs through b-oxidation to form acetyl CoA for use in the Krebs cycle.

Immediately post-meal, the metabolism in the liver is to produce glycogen from glucose for storage and to also produce fat from excess glucose which will be eventually stored in adipose tissue.

In the early fasting state, fats become critical for energy production and for glucose sparing. Fatty acids contribute to glucose production in the liver via gluconeogenesis by their contribution of the glycerol molecule. In an overnight fast most of the glycogen stores are completely diminished in the muscle and liver making de novo synthesis of glucose essential and the breakdown of fats necessary. During exercise carbohydrates and fats, proteins and carbohydrates provide the energy needed by skeletal muscle. However at rest and during light activity it is fat that is the predominant fuel source. During rest and daily activities fats provide 80% to 90% of energy whereas carbohydrates provide 5-18% and proteins provide 2-5% (Sherwood 2004; Gropper 2005).

PA and Type 2 Diabetes

As physical activity in light to moderate amounts (i.e non-endurance) results in adipocyte mobilization it can be considered an effective way to reduce adiposity considering an individual incorporates dietary changes to discourage weight gain and storage of fats. PA is currently an accepted therapeutic approach to preventing type 2- diabetes (Lindström, Ilanne-Parikka et al. 2006). The post absorptive or pre- fasting state and physically active states are important for people at risk for diabetes as adipocyte concentrations can be reduced. Paediatric

obesity, in particular paediatric metabolic syndrome (classified as having 2 or more existing conditions of high BMI, cholesterol blood pressure , triglycerides and glucose in the >75th percentile and low HDL cholesterol in the <25th percentile) is a risk factor for multiple diseases and can be accounted for increased risk of development of type 2 diabetes later in life. In this particular study even having one components of metabolic syndrome significantly increased ones risk of developing type 2 diabetes. Yet authors conclude results are similar if one were to predict outcome based on BMI alone (Magnussen, Koskinen et al. 2010). Obesity is a condition of excess energy intake and decreased energy expenditure. Physical activity is therefore a primary method to prevent obesity related diseases.

PA and Youth

Youth (children ages 5-11) are recommended to obtain approximately 60 minutes of physical activity per day daily in order to maintain good health (AHKC 2012). The exercise should include moderate (playground activities) to vigorous activity (running, brisk walking, sports etc.) every day, and vigorous activity for 60 minutes on at least 3 days per week. Bone strengthening activity in the form of resistance activities should be also included 3 times per week (CSEP). As school is a routine occurrence in everyday life, it is an ideal place for children to engage in moderate to vigorous physical activity (Dobbins 2009).

PA in youth is encouraged as the obesity epidemic is increasing. In 2004 the obesity prevalence in Canadian youth, excluding the territories, was in the range of 8% to 12% and was approximately 6% higher than in 1978-79. Overweight prevalence was found to be in the range 15% to 22% in 2004 and was an increase of approximately 4-5% since 1978-79 (Sheilds 2010). Therefore reaction to the epidemic calls for increasing awareness about prevention strategies which include physical activity.

Canada's First Nations and Inuit Regional Health Survey (FNIRHS) consists of data of surveys collected in 9 regions including all provinces of Canada collected in 1996 and 1997 from Canada's Aboriginal Communities. All regions included information of health related factors except Alberta. Child specific health data revealed that the overall prevalence of overweight in Aboriginal youth was 3.4% (age 0-5 years), 5.9% (6-11 years) and 10.1% (12-18 years) (MacMillan, Jamieson et al. 2010).

Interventions Targeting PA in Youth

In 2004 in response to the adoption of a "Global strategy on Diet, Physical Activity and Health" the WHO called on countries and within countries to "work with key partners which include schools, health professionals, consumer groups, the research and private sector to provide a comprehensive strategy to increase physical activity in youth and children". Effective interventions to increase PA in children include varying strategies and outcomes measured.

A 2009 Cochrane review outlined successful interventions with strong methodologies to support the goal attainment. It was found that creating a lifestyle that increases physical activity during childhood is most effective when it is likely to carry on through to adulthood. Authors provide a variety of recommendations for PA interventions aimed at schoolchildren.

Key factors in the promotion of healthy schools include; encouragements to schools and school boards for incorporating these interventions, interventions should be for all developmental levels and enhance positive attitudes toward physical activity, teachers and staff should model positive physical activity, parental involvement is beneficial when trying to incorporate more PA, schools should make extra PA a priority, and public health staff should lobby for increased PA amenities in schools (Dobbins 2009).

Research endeavours must concentrate on the accumulation of data on physical activity rates and duration, measurements of the intervention should be

validated, barriers and facilitators should be assessed, subgroup analysis should be assessed (age, gender, ethnicity, SES), follow up data should also be collected and funding agencies are urged to recognize the need to fund long term interventions (Dobbins 2009).

Detail of Successful Studies

The Oslo Youth Study was implemented in 1979 and consisted of a health education program designed to prevent cigarette smoking, improve eating habits, and to educate youth about physical activity. The objective of the PA component was general education and to increase maximal oxygen uptake levels. Maximal O_2 levels were measured at baseline to motivate change. All students were taught special endurance exercises during PE by the intervention staff, and students considered not active were involved in a special program also implemented by research staff. The intervention was for 12 sessions and lasted 1 year. Physical fitness of these adolescents at 13 years of age was determined to predict BMI and anthropometric measures as well as blood pressure in a beneficial manner. These associations remained relatively consistent at follow up at 15, 25, and 33 years of age but were diminished at 40 years of age. These findings conclude that physical fitness in youth is protective against cardiovascular risk factors in adulthood by improving BMI, blood pressure, and anthropometric indices (triceps skin fold thickness) (KLEPP, ØYGARD et al. 1994; Klepp 2009) .

The West Australian Schools Physical Activity and Nutrition Project (WASPAN) was an "enrichment" project developed to engage at risk children at school as well as to complement the normal WASPAN health program for all children. The WASPAN general PA program consisted of 6 classroom lessons and twenty minutes of extra PA per day whereas an enrichment program for children involved the incorporation of parents and home time with more personalized attention from teachers . PA diaries were used to identify preferred activities and collaborative goals were set and monitored between student-teacher and parent. The intervention took place over 20 weeks. Physical fitness

measured via a shuttle run test was found to have been significantly improved in enrichment and WASPAN program schools in both girls and boys at follow up after 6 months post intervention and at the end of the intervention.

The Enrichment program was successful in reducing television viewing in boys at a significant level compared to controls and WASPAN program schools and was still reduced at 6 months follow up post intervention. Subscapular skinfold measurement were changed significantly in enriched girls at follow up, and sodium intake was significantly lowered in enrichment schools in both boys and girls. Cholesterol levels were also shown to be significantly lowered in high risk boys and girls in the enrichment group at 6 months follow up and were found to be lowered significantly in enriched girls at endpoint (Burke 1998).

The Heart Smart program was developed in 1992 in order to address children's health issues; more specifically cardiovascular disease and its initiation in young children. It was a comprehensive program that included a health curriculum and a Superkids-Superfit component to be incorporated by teachers as "an integral part of the educational system". Unique to the program was involvement of parents and the focus on children's self- esteem. The Heart Smart program aimed to develop children's assertiveness , decisions making skills, and self- esteem in order to prevent the adoption of unhealthy lifestyles such as smoking, alcohol and drug abuse (Berenson 1993). The Heart Smart program was effective in improving fitness as measured by a run/walk test particularly in fifth grade boys, children who had altered school lunches showed a greater decrease in cholesterol reduction, and intervention schools demonstrated a greater increase in HDL cholesterol (Arbeit, Johnson et al. 1992).

Step Two was a 9 month school based intervention for overweight and obese children in Germany. Specialists were employed for the intervention and included a gymnast to incorporate 60-90 minutes of vigorous PA 2 times per week. Aerobic dance, endless relay, and soccer games were examples of the PA

interventions (Graf 2005). The step 2 program showed significant reductions in BMI and systolic blood pressure in the intervention group compared to the control group (Graf 2005).

The CATCH (Child and Adolescent Trial for Cardiovascular Health) multicentre intervention involved a PA component entitled CATCH PE, as well as classroom curricula. PE teachers were given training on appropriate methods to engage children in Moderate to Vigorous Physical activity during PE and ideas on how to maintain physical activity throughout life. CATCH PE was implemented for a minimum of 90 minutes per week over two school years and MVPA was to be engaged in for a minimum of 40% of the PE class (McKenzie, Nader et al. 1996; Perry, Sellers et al. 1997). The intervention schools engaged in more MVPA in gym class than control schools and was increased approximately 9% from the baseline measure. Children in the intervention group reported 12 more minutes of daily PA, and ran 18.6 more yards in a 9 minute run test than did controls (McKenzie, Nader et al. 1996).

The Know Your Body program in New York was designed and trialed on two demographically diverse populations from fourth grade into eighth grade. The objective of the PA component was to adopt healthy physical activity habits and used the health belief method. This special curriculum was taught in classrooms for 2 hrs. /week by an intervention trained regular teacher. Research staff monitored the teachers progress as well (Walter, Hofman et al. 1988). The Westchester county schools had a decrease of 8.5 mg per deciliter in plasma total cholesterol over a five year period, and the Bronx area schools decreased their net cholesterol by 5 mg per decilitre in the five year period. The intervention also showed decreases in net fat intake in both areas, and an increase in healthy knowledge that was measured by a questionnaire.

Supplemental Fitness Activities in Urban Elementary Schools took place in Cleveland and one elementary school received fifteen weeks of the supplementary PA. Unique to this study was the provision of PA by medical students. The medical students used resources provided by the CDC of best practices for exercises which engage users in exercises which raise their heart beat. Medical students also used warm up and cool down periods while presenting educational lessons on PA, nutrition, and disease prevention (Stephens and Wentz 1998) . Results showed favorable increases in the intervention group for flexibility (measured by a sit and reach test), body composition (as measured by sum of skinfold measurements) and heart rate response to submaximal exercise.

The Bienestar (well-being) Health program was designed for Mexican American children living in Texas. The program consisted of 50 sessions over 7 months. Program development used the social cognitive theory, personal factors, social systems, behaviours, social ecological theory and cultural appropriateness. The Bienestar program included health curriculum lessons including physical activity lessons 4 times per week for 45 minutes, and a weekly after school club where parents were urged to participate as well. Parents were also invited to a Family fun fiesta once per month where PA activities were also enjoyed (Trevino, Yin et al. 2004). This particular intervention was specifically targeted at diabetes prevention and fasting capillary glucose was a main outcome measure. Participants in the intervention group had decreased capillary fasting glucose at endpoint compared to baseline measures. Participants in the intervention group also showed increases in their dietary fiber consumption and fitness scores at endpoint. Physical fitness was assessed using a modified Harvard step test.

Pathways is a culturally appropriate intervention for American Indians and shows favorable increases in cultural knowledge and identity. Pathways' was

integrated into school curricula and parents were urged to be involved as well. Educational storytelling and classroom PA were used to encourage positive physical activity habits. Role modeling and physical activity diaries were also used to enhance PA. Family celebration events were held after each year and had children displaying their learned PA, and also had a final 2 km "Great Race". The home family component was entitled Family Packs and families engaged in approximately 10 per year through the intervention. PA Family packs were entitled "action packs" and consisted of a reiteration of classroom curricula and also suggestions for activities children can try at home with their friends and family. Return cards were signed by the student and parents after each family pack and returned to school for review (Davis, Clay et al. 2003). Intervention group participants had higher scores on their healthy eating and physical activity questionnaires at the end of each school year compared to the control group. The intervention group also displayed a greater retention of this knowledge when re tested after the three year trial.

The SPARK (Sports, Play and Active Recreation for Kids) intervention used physical education specialists or trained regular teachers to implement a physical activity program. The intervention consisted of a skills component as well as a physical education component. The intervention used PE classes of 30 minutes in length and three times per week to introduce 15 min of progressive MVPA activities, and 15 minutes of skill building lessons. Examples of MVPA activities included jogging, aerobics, jump rope, and low activity games such as softball were modified to in order to make them more active. The self-management program aimed to encourage PA engagement to outside of the classroom by teaching self-monitoring, stimulus control, goal setting, self-reinforcement, self-instruction, and problem solving skills. Homework and newsletters were assigned to engage parents to become involved with physical activity with their children as well (Sallis, McKenzie et al. 1997). The SPARK program revealed that the intervention students who were led by a specialist

engaged in twice as much time in MVPA exercises in PE than controls. Girls in the specialist group improved their mile run test, as well as abdominal strength to a greater extent than did the control group.

Four out of seven schools in a Dutch Netherlands randomly assigned trial looked at the effects of providing game equipment during recess and lunch breaks. The design of the study included the provision of the equipment with activity cards before the breaks by the research staff. Each class was provided their own equipment and teachers were urged to motivate children with the equipment. This study was shown to increase the intervention group's MVPA at lunch and their moderate activity during recess (Verstraete 2006) .

Recess and Lunchtime Physical Activity

Typically, recess and lunchtime breaks combine to offer approximately one hour and twenty minutes of outdoor leisure time. Outdoor leisure time is often a reliable source for children to engage in physical activity. Ridgers et al. used a social ecological framework to identify correlates of positive physical activity associations during recess and lunchtime breaks in 53 studies worldwide. Ridgers et al. identified unfixed play equipment, and overall play facilities to be positively associated with physical activity and perceived encouragement from friends, parents, school and teachers to be the likeliest associated with increased physical activity levels (Ridgers, Salmon et al. 2012).

Behaviour Change Techniques

A 40 item taxonomy proposed by Michie et al. lists common behaviour change techniques used in interventions for physical activity and dietary change. Appendix E sites these techniques. This is an exhaustive list, and merits critical study when applying an intervention to school children (Michie, Ashford et al. 2011).

Physical Activity Behaviour in Children

The scope of children's engagements in physical activity is understood by the examination of behaviour related to intention, and facilitators of physical activity which inevitably also include the barriers as well. As programs and institutions strive to adapt to evolving physical activity needs; several factors calculating behaviour occur in relation to physical activity and children.

Social and physical environments including schools, families, and neighborhoods are predictors of a child's health beliefs and related behaviours. Ecological models use the theory that it is the environment which predicts healthy or unhealthy responses in mood, performance or physiology. Bauer et al recognized that the principles mentioned above and as proposed by Bronfenbrenner and Stokols elucidated the need to develop environmentally effective intervention rather than individual targeted interventions (Bauer, Patel et al. 2006). Research which strives to understand the environment and ecological factors affecting children's physical activity behaviour is warranted.

As stated, school settings are locations affecting childhood physical activity pursuits as well. Schools have various means to engage the students in healthy behaviours which include; school policies concerning physical activity including teacher inclination toward the inclusion of physical activity and teacher skills and knowledge as well as the literal built environment effecting opportunities for physical activity such as playgrounds and opportunities for physical activity in and around the school which include active transportation and extracurricular activities. Community relationships with schools are also considered factors affecting childhood physical activity behaviour (Lagarde and LeBlanc 2010).

In fact it may be more realistic to propose that interventions targeted toward increasing physical activity in children are only momentarily effective, and to maintain these positive behaviours would mean changing some ecological model factors. Perry et al. described specific contents of the ecological model as

consisting of; policy, environment, sociocultural, community, social networks and intrapersonal factors forming a diagram with policy describing the greatest amount of the ecology and the other factors contributing proportions equal to their list as described. A review of studies involving adolescents revealed that other more substantial ecological factors be targeted through ecological interventions rather than just the intrapersonal intervention in order to affect change (Perry, Garside et al. 2012).

In children of elementary school age, there are also similarities within the literature to suggest changing the focus of intervention is the state of the art at the moment. Jay E. Maddock proposed there are certain areas in the school which can be targeted such as transport to and from school (targeting active transport), school grounds, PE class, recess and classroom breaks and policy change is simple and effective at moderating these factors in order to optimize opportunities for physical activity at school (Maddock 2012).

An implementation of a daily physical activity policy in Ontario region schools, which consist of a minimum implementation of 20 minutes of MVPA activity per day during instruction time, is an example of how a policy works to modify positive behaviours related to physical activity. Engagements in DPA (daily physical activity) were proven to positively associate with MVPA during school, and weekdays as measured by accelerometers regardless of how many bouts of MVPA children attained in the 20 minute provision of DPA (Stone, Faulkner et al. 2012).

Interventions of Physical Activity

Metcalf et al conducted a review to comprehend to what extent physical activity interventions affect the overall activity levels of children though systemic, and meta-analysis of intervention and randomized control trials. Authors conclude that intervention trials have a very small effect on actually increasing the overall activity levels of children (Metcalf, Henley et al. 2012)

Other Behavioural Determinants Related to Youth and Physical Activity

Urban sprawl has been discussed thoroughly in relation to incidence and prevalence of obesity and overweight of individuals residing in urban areas. Urban sprawl is characterized as metropolitan areas located in large geographical areas thereby theoretically increasing the likelihood of increased automobile usage. Seliske et al. reported urban sprawl to be positively associated with active transportation and MVPA in Canadian youth age 12-15 years old. These findings were not similar to other studies looking at urban sprawl related behaviours suggesting the common philosophies about urban sprawl are not steadfast when considering children (Seliske, Pickett et al. 2012).

As will be discussed more thoroughly in the following sections, negative behaviours exposed towards peers such name calling and bullying are demonstrated in qualitative studies to have been barriers in implementation of school policies and also to be associated with weight problems in children. Interestingly, a study completed in Italy used physical activity enjoyment questionnaires with a peer victimization questionnaire administered directly after to assess the link between the two variables. The study found peer victimization in the form of verbal victimization to be negatively correlated with positive enjoyment of physical actively and positively correlated with low enjoyment of physical activity. Participants were 12-13 years old and participating in physical education class (Scarpa, Carraro et al. 2012).

Physical Activity Interventions in the Community of Kahnawake with the Kahnawake Schools Diabetes Prevention Project

Holistic in nature, these interventions include a health curriculum for schools, recreational and community activities which promote Living in Balance. The interventions are planned to meet the needs of the Native culture of the children of Kahnawake (KSDPP). The KSDPP's goals are to change physical environments and social norms in order to promote physical activity and healthy eating. An intrapersonal intervention, described as changing behaviour through direct interaction between intervener and subject has been shown to have been

effective in many studies, although not sustained, but has not been applied by KSDPP and warrants investigation and implementation (Levesque 2005).

School Based Interventions at KSDPP (Kahnawake Schools Diabetes Prevention Project)

Schools are involved in an annual racers for health run, and an innovative daily 20 minute walk were perceived as successful intervention and are continued by the KSDPP. These interventions are constant with an ecological model that uses multi-level strategy and is culturally relevant(Levesque 2005).

Community Based Interventions at KSDPP

KSDPP and partners established biking and walking paths in the community. The community of Kahnawake's existing recreational organizations adopt KSDPP's core values thus perpetuating these healthy lifestyle behaviours throughout the community. KSDPP supported the creation of gymnastic and line dancing clubs and continues to collaborate with the Kahnawake Youth Center to strengthen programs offered (KSDPP).

PA Policies in Schools

Effective policies in schools are essential for incorporating PA in a manner sufficient to enhance positive attitudes towards PA while incorporating sufficient amounts of PA into the child's daily life.

Some strong policy options for PE classes include: daily PE throughout the school year to provide a variety of choices, and to ensure students are active during PE. Policy options for the curricula include: training of teachers in general on how to incorporate PA into the curricula, and the integration of the health belief model into the curricula as well. Policy should also be implemented for extracurricular activities at school which include intramural activities, sports, scholastic activities, and active recess. Policies should include the training of PE teachers, PA leaders and other school staff in order to ensure proper school programs (Lagarde and LeBlanc 2010) .

Components considered important outside of the school are the possibility of active transport (paths to school to allow children to walk or bicycle to school), proper facilities to encourage PA (bike racks) and the opportunities for community sharing of PA localities such as allowing children to visit parks during school hours and allowing the use of schoolyards for non-school hours (Lagarde and LeBlanc 2010).

Further research, warranted by the WHO, includes incorporating programs which recognize the needs of different groups such as children of different ethnicities, children with disabilities, gender specific activities, the consideration of pre-school children in developing programs appropriate for them. Addressing workplace health and wellness to ensure staff are in good physical condition to meet all the needs of the children in the inclusion of PA is warranted as well.

Nutrition and physical activity policies often occur hand in hand, some good policy intervention in schools include obtaining contracts with local food producers as suggested by the WHO's Global Strategy on Diet, Physical Activity and Health. Local farm to school programs or even school gardens are considered a strategy in obesity prevention by some (McKenna 2010).

Policy and DPAS (Global Strategy on Diet, Physical Activity and Health)

DPAS: more specifically the global strategy on diet, physical activity and health was delivered by the WHO in 2004 to guide groups such as member states, the private sector and NGO's among others, to facilitate the adoption of strategies to improve the current state of non-communicable diseases (NCD's) such as diabetes.

A DPAS toolbox was created and includes resources for the implementation of various policies for improvement of diet, population based approaches to increasing levels of PA, reduction of salt intake and the workplace prevention of NCD's. DPAS also has tools for monitoring and evaluating policies.

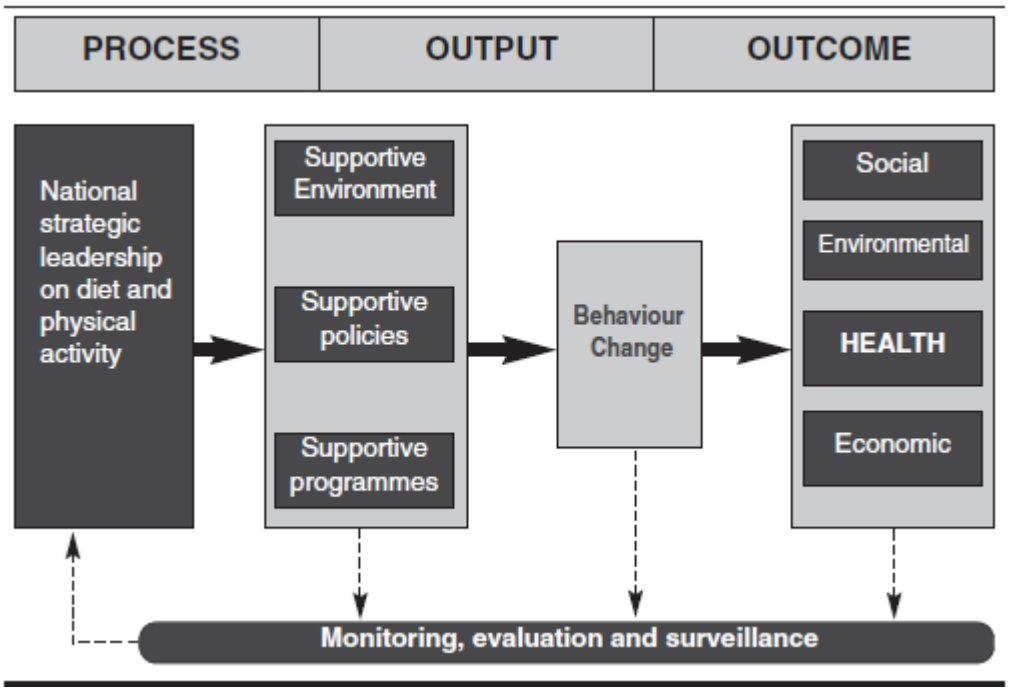
Schools are an ideal place to implement DPAS as children can be directly benefited by the incorporation of the delivery of the policy. Health Canada and the Public Health Agency of Canada contributed to the framework of the DPAS and contributed two articles which offer an in- depth review of effective school policies which were discussed in the preceding section. Policies are believed to extend beyond immediate health benefits and to improve social, environmental, and economic factors as well. Theoretically the DPAS was conceptualized because the improvement of diet and PA are thought to be a societal issue rather than an individual issue (Candeias, Armstrong et al. 2010) .

The Play On study in Ontario was a multi school study of 5th and 8th grade children. The Play On study sampled 30 elementary schools with convenience samples of children to better understand PA levels and their correlation with school characteristics. The Healthy School Planner (HSP) was used to determine school data, and the SHAPES (School Health Action, Planning and Evaluation System) questionnaire was used to obtain student characteristics. The HSP tool measures a Healthy Physical Environment, Instruction and Programs, Supportive Social Environments, and Community Partnerships. The measures were assigned based on their phase of action such as "initiation" or "action". It was found that schools in the action phase of using interschool physical activity programs was significantly associated with children who are not overweight or obese compared to schools in the initiation phase of using interschool physical activity programs (Leatherdale 2010) .

The SPEEDY (Sports, physical activity and eating behaviour: Environmental determinants in Young people) study in the United Kingdom recruited 1908 children across 92 schools to examine Actigraph accelerometer measured physical activity with school level correlates. The study found that having a written or informal policy was associated with less time spent in moderate to vigorous physical activity, yet the provision of a lollypop person (someone to assist children walking into school grounds) and objectively measured walking accessibility will increase minutes engaged in moderate

activity. Sports facilities of high or medium quality and pedestrian training (enabling children to travel independently) were associated with greater MVPA. This study used a significant factor set at α=0.1 (van Sluijs, Jones et al. 2011). The authors concluded that there was an unexpected result from the availability of an informal or written policy. Suggestions for the phenomenon include the adoption of physical activity promotion campaigns which inhibit the level of PA (van Sluijs, Jones et al. 2011). The adoption of an informal policy may also be considered causal in the negative association with vigorous activity due to the lack of importance placed on physical activity, or physical inactivity is a motivating factor in school change.

Figure 3: Changing PA levels in society(Candeias, Armstrong et al. 2010)



Behaviour Change Models

Some common behaviour change techniques include the PRECEDE model from 1953 (cues, prompts, and reinforcements), the social learning theory, and the health belief model. Social learning theory suggests change accompanies social support from the environment, personal factors and attributes of the activity. The health belief model uses the teaching of knowledge of health outcomes which are associated with the activity to encourage behaviour positively (Dobbins 2009). Social cognitive theory encompasses many behaviour change techniques and can measure behaviour change by assessing various qualities such as outcome expectations, self- efficacy, self- regulation and social support and is also potentially useful to design interventions targeted at changing behaviour (Poddar, Hosig et al. 2010).

Abraham and Michie recounted their 40 item taxonomy of Behaviour Change Techniques in order to improve reporting and repeatability of behaviour change techniques used in interventions. The 40 item taxonomy uses well established behaviour change techniques to help people change their physical activity and eating behaviours. Details can be found in the Appendix E.

PA Assessment Methods in Children

Assessments of physical activity are useful when designing interventions targeting children and physical activity. Initial quantitative data on physical activity levels, which include duration and intensity, help the researcher better understand their target population. Gold standards of measuring PA include direct observations, the doubly labelled water technique, and indirect calorimetry. Secondary measures include accelerometers, pedometers and heart rate monitors. And lastly, subjective measures such as surveys and questionnaires are also used and are helpful tools to describe the kinds of activities children partake in. Gold standards measure energy expenditure and have been used to evaluate secondary and subjective measures of physical activity (Sirard and Pate 2001).

System for Observing Play and Leisure Time Activity in Youth (SOPLAY)

The system for observing play and leisure time activity in youth is a direct observation method used to measure the physical activity of children through momentary time sampling where areas are scanned and children's level of physical activity while playing in areas is assessed by the evaluator as sedentary, walking or active. The unit of analysis in this system is one scan of an area (pre-determined on a map of schoolyard). From one scan of an area the observer will identify the number of children in that area and the number of children engaged in sedentary, walking or active activity.

It is considered a gold standard measure and has been used in studies assessing children's physical activity at school. This system also allows the observer to analyse contextual variables such as organization of sport by staff (a scheduled activity with leadership), supervision by a schoolyard monitor or teacher(monitor or teacher directly adjacent to the area observed) , and the provision of equipment (provided to students, not including permanent facilities such as basketball nets)(ALR). Temperature is also usually recorded with this method. In studies using this method of analysis; it is the proportion of students engaged in differing levels of activity which show the association of contextual variables. Such studies give an accurate description of the activity levels of the children at the schools and the relation to contextual variables. Each school is different and this type of analysis offers insight into the schools atmosphere related to physical activity during breaks such as recess and lunch. SOPLAY offers the researcher a tool for incorporating more effective interventions by understanding the current levels of children's physical activity. Construct validity for the SOPLAY system has been demonstrated with heart rate monitoring (McKenzie, Marshall et al. 2000; McKenzie, Crespo et al. 2010; Willenberg, Ashbolt et al. 2010).

The SOPLAY form, which can be found in Appendix A, has boxes allocated to sedentary, walking and active behaviours. Active behaviours correspond to children engaged in vigorous physical activities, walking refers to children walking or moderate activities such as playground activities, and sedentary behaviours include sitting , eating, screen time etc.(AHKC 2012) .

Centers for Disease Control Guidelines on PA

The U.S CDC identified epidemiological factors associated with a poor diet and physical inactivity and identified intermediate outcomes which include; obesity, metabolic syndrome, inadequate bone health, iron deficiency, eating disorders, and dental carries.

Guideline 5 states schools should implement health education that provides students with the knowledge, attitudes, skills, and experiences needed for healthy eating and physical activity.

Expectations for children after health curricula for physical activity include; engaging in moderate to vigorous physical activity at least 60 minutes per day, regularly engage in PA that enhance various factors (cardiorespiratory fitness, muscle endurance and muscle strength), engage in warm up and cool down activities (before and after exercise), drink plenty of water (before, during and after PA), follow a PA plan for healthy weight management, avoid injury during PA, and to support others in being physically active (Centers for Disease and Prevention 2011) . The CDC guideline is holistic and also suggests that school mental health, health and social services address healthy eating and physical activity consistently. The involvement of the community and parents into the education of PA for children is also suggested.

Socioeconomic Status and Physical Activity and Other Risk Factors

SES (socioeconomic status) as defined by income, education level attained and occupation; has been shown to modestly impact several health outcomes and related behaviours. In considering its impact on overweight and obese children, the highest SES quartiles were found in the Canadian adolescent population to coincide with the lowest proportion of overweight and obese children. Single parent vs. two parent families was also found to include the greatest proportion of obese and overweight children (Tremblay and Willms 2003).

Factors affecting and associated with being overweight or obese include low participation in organized sport, higher(>3h per day) of television viewing time, greater use of video games, lack of participation in clubs, decreased participation in art and dance classes and low participation in un organized sports (sports without instruction or coaching) (Tremblay and Willms 2003). Intramural and extra mural sports at secondary school are shown to positively correlate with physical activity after secondary school in Montreal. Students at schools with greater intramural opportunities show a trend towards continued PA despite their level of SES (Fuller, Sabiston et al. 2011). Even though the evidence examines secondary school it may be an important factor to consider for elementary schools as well (Centers for Disease and Prevention 2011). Therefore school settings are an important place to provide more opportunities to disadvantaged youth by incorporating curricula that consider all aspects of the etiology of physical inactivity.

A recent statistic Canada community health survey (CCHS-Canadian Community Health Survey) collected data on individuals living with diabetes (T2DM, T1DM, and gestational diabetes mellitus) and found a link between income and having a diagnosis of diabetes. In general they conclude diabetes prevalence decreases steadily as income becomes higher and that policy approaches should consider the role of socioeconomic status in the risk of T2DM (Dinca-Panaitescu, Dinca-Panaitescu et al. 2011) .

Academic Achievement and PA

Overall, the literature based on association between PA/PE on academic performance is mostly positive or neutral. Authors conclude there are no reasons that time spent on PA/PE are a discouragement to academic success.

Rasberry et al. reported the results of their literature review which searched for associations between measures of academic performance (cognitive skills and attitudes, academic behaviours, and academic achievement) with PE or PA (recess, PE, classroom PA, and extracurricular PA). Rasberry et al concluded that out of 43 studies selected there were 251 associations made. The associations were as follows; 51% were positive, 48% neutral and 1.5% negative for the associations of measures of academic performance. In this study both intervention and non-intervention studies were identified and also descriptive studies, longitudinal and cross sectional studies were included. This study also concluded that recess was beneficial in improving focus and classroom behaviour in eight studies (Rasberry 2011).

Bullying and Negative Behaviours

The Project Playground at KSDPP which will be discussed in our study was designed to increase physical activity and to reduce negative behaviours as well. This strategy is important as there is literary evidence that there are other factors present that may interfere with physical activity at school (Bauer, Patel et al. 2006). Negative behaviours or bullying include teasing, name calling, and exclusion. The psychosocial impacts of these behaviours are concerning and negative behaviours should be addressed when attempting to make lifestyle changes such as increasing physical activity in a school setting.

It was found in a qualitative study of overweight youth in Canada, that bullying was identified as a barrier to maintaining a healthy weight, and that it was offensive language, intimidation and exclusion by peers and siblings that were commonly reported by study participants (Thomas and Irwin 2009) .

In the Health Behaviours of School aged children study in Wales, UK there were significant associations between obesity and reports of being bullied several times per week. More specifically, obese children were four times more likely to report being bullied than overweight or normal weight children at four years post baseline. At 11 years post baseline, these associations were no longer significant to suggest there was an association of obesity and reports of being bullied. Perhaps it is reasonable to conclude that bullying is a counteractive behaviour in the adoption of a healthy weight for obese individuals. And the possibility that bullying is causal in the development of obesity in childhood years could be true as well (Elgar, Roberts et al. 2005).

Qualitative studies of school barriers to the successful implementation of school health policies also identify negative behaviours as a discouraging aspect in maintaining a healthy school. One study identified that weight related teasing was a barrier to successfully implementing a school physical activity policy and that changes needed to occur by a coordinated approach in order to reduce bullying and successfully implement health policies (Bauer, Patel et al. 2006). One study also included students' perceptions and also found that it was teasing and bullying by peers, usually males to females, based on one's ability that reduced their interest in engaging in PA. Comments about a student's abilities by staff were a discouragement as well (Bauer, Yang et al. 2004).

Objective

The objective of this research project was to describe and assess the physical activity levels of children attending elementary schools during their lunch and recess breaks using the SOPLAY methodology. This study occurred during the implementation of a physical activity intervention thus observations were taken with the presence of an intervention and without. Children were observed over 3 months from September 2011 to December 2011 inclusive. The number of children in an observational scan was coded as vigorous physical

activity, sedentary, and walking activity. The types of activities children were engaged in were also described in order to understand preferred activities. Days of observation with and without an animator were compared. Contextual variables were also recorded. The contextual variables included; the presence of a supervisor provided during breaks by diverse sources (monitor, teacher, intervention animator or other staff), the provision of equipment (by the intervention staff or equipment made available by the school not including permanent facilities), and the organization of activity (scheduled activity or an activity with leadership). Temperature was recorded in order to study temperature effects on physical activity.

An intervention, interpersonal in nature can presumably increase the level of physical activity in children, yet in this setting may not be thoroughly implemented due to the nature of this study (i.e. a large population for a short period of time). However, interventions targeted toward recess and lunchtime has been shown to also increase levels of physical activity of children due to interpersonal factors such as equipment provision and instruction. The context will influence the physical activity nature of children; however, the extent will be determined.

Field notes were also recorded during the study in order to obtain knowledge about the school atmosphere during recess and lunch and to examine negative behaviours as they relate to the health atmosphere of the school. Field notes were recorded immediately before recess as children prepared to leave the school building until they were outside and then recurrently when outside during observations. Peer bullying is likely to be present in physical activity opportunity settings.

Implementation of the Physical Activity Intervention Entitled "Project Playground"

Kahnawake has a total of 3 elementary schools; however project playground was designed to accommodate two schools. The animator would alternate days, four days per week during recess and lunch breaks outside. The

animator commenced the intervention in September 2011; she was present approximately four days before observations for this project commenced. Only one school was observed in this study making it feasible to describe activity levels under the circumstances of the animator being present or not present. The community has never allowed studies comparing the schools as they are very different and recruit different children. One school is a language immersion school that teaches in the Mohawk language and the other provides instruction in English. The English school was studied.

The role of the animator was to implement fun, "old-fashioned" playground games such as hopscotch and jump rope with the intent of increasing activities and to decrease negative behaviours associated with breaks such as bullying etc.. The animator's visited the school grounds every other day with her own bag of equipment supplied to complement the project playground; it consisted of jump rope, Frisbee, chalk for the cement, plastic balls, and other items she determined relevant for the success of the project. The equipment was supplied to the children with instruction for playing with them and games (soccer, hopscotch, jump rope and four square) were also organized by the animator.

KSDPP Code of Research Ethics

The KSDPP code of research ethics stipulates the main responsibilities of researchers when research is undertaken within the organization. The review and approval process for ethically responsible research includes; being affiliated with a university and then submitting a letter of interest to the KSDPP scientific director. If approved, introduction and consultation meetings are completed with the Research team; (academic researchers, research trainees, community based researchers, and community members from various backgrounds and stakeholder groups or CAB which is an acronym for the Community Advisory Board). A detailed research proposal is submitted after consultation meetings with research team. Final research ethics approval is obtained from the research team and community advisory board with a certificate of approval from the CAB (KSDPP).

After approval with quorum from research teams and community boards, ethics approval to conduct the study within the community education system was obtained from the Kahnawake Combined Schools Committee in order to conduct research at the said Kahnawake school of Kateri. The research team and community advisory board are a partnership between community members and research affiliates from McGill University, Universitè de Montreal and Queens' University.

McGill University Research Ethics Board

A certificate of ethical acceptability of research involving humans was obtained from the Research Ethics Board III of McGill University after research ethics approval at KSDPP.

Methods

Participants

The participants chosen for this project were the children attending the elementary school of Kateri in the Mohawk Community of Kahnawake. Kateri School is English primary and elementary with a total of 230 students. Only the boys and girls enrolled in grades 1-6 were included in the present study. Children were observed participating in recess and lunchtime breaks. No children were personally identified but counts of children doing various activities were recorded. The activity levels of boys vs. girls was not recorded or taken into consideration.

Measurement

SOPLAY

With a desire to use an accurate method to assess recess activity in schools, several methods were considered with SOPLAY being the most suitable

for this research project. Literature cited the SOPLAY method as useful to capture leisure activity of youth. SOPLAY is cited on the Active Living Research website as a tool suitable for researchers, practitioners, and community advocates. It was developed by Thomas McKenzie and is "based on momentary time sampling techniques of individuals in pre- determined target areas". In summary, the form which can be found in the appendix details the method of sampling. In preparation for the assessments, a map of the playground was drawn to divide it into areas numbered 1-7. Map is located in Appendix D. The area of playground was recorded in a numerical format; the temperature and contextual variables were also recorded. The total number of children engaging in active, walking, or sedentary activities was recorded for each 20 minute recess and 1 hr. lunch break and covered as many scans of each area as possible. Each area for which data were recorded was counted as a scan or considered a sample in this study. SOPLAY is a useful resource for this type of study as it offers an objective measure in an open environment of a group because it accounts for the variable activity levels and varying number of participants. It is also an alternative to individual measures such as accelerometers, doubly labeled water and heart rate monitors. Such measures would be more appropriate in the assessment of long term activity levels, and experimental studies and would be time consuming to use for short periods of time (Willenberg, Ashbolt et al. 2010).

The SOPLAY form, which can be found in Appendix A, has boxes allocated to sedentary, walking and active behaviours. Active behaviours correspond to children engaged in vigorous physical activities such as running, walking or moderate refers to children walking, and sedentary behaviours include sitting , eating, screen time etc. (ALR ; AHKC 2012).

Temperature was assessed daily on the Weather Network once before recess and before lunch.

Field-notes for an Ethnographic Description

Notes recorded by a research scientist before or after observation, were recorded to capture outstanding events. Observations about the atmosphere of the school during break periods were recorded. The field notes were a secondary subjective measure of this study. A calendar notebook and journal ensured accuracy of field notes.

Sampling

The sample used in the present study was counts of the number of children engaged in activities in specified areas of the children's playground (McKenzie, Crespo et al. 2010). We sampled the children for 36 days and obtained 1361 scans.

Statistical Analysis

Statistical analysis to determine activity levels and associations of the contextual variables and temperature was carried out with the Graph Pad Prism software for Windows PC. Linear regression, correlation, and t-tests and ANOVA were used to determine statistical significance. Mann Whitney, Kruskal Wallis, and Spearmen correlation statistical methods were used. A p-value of 0.05 was used to determine significance. Databases in Excel 2010 were used to enter and store the data.

Results

Collection of Data

During the course of the study, we obtained 1361 scans in total; 643 scans were collected with the presence of the animator and 718 without her presence. In total observations were taken over 36 days on Monday through Thursday.

Observations over the 36 days, when combined to include all of the scans revealed the average number of children per scan observed engaging in sedentary activity was (0.49, ± 1.21), for walking activity (7.22, ±6.96), and for active (2.94, ±4.38). The number of children in each level of activity children engaged in were statistically significantly different from each other ($P<0.05$) determined from a Kruskal-Wallis test for non- parametric one way ANOVA. Results obtained when the intervention animator was present and applying the project were as follows; sedentary (inactivity) comprised on average (0.51, ±1.21) children/scan, walking (7.22, ± 6.93) and active (vigorous) was on average (3.15, ± 4.69). And this value was obtained over 643 scans. When observations were observed without the animator, the average number of children per scan engaged in sedentary was (0.47, ± 1.21), walking (7.23, ± 7.0) and vigorous was (2.75, ± 4.08) and found no significant differences when the two values were compared. And this was observed over a total of 718 scans without the dedication of the animator. Examples of sedentary activity included standing near the wall, sitting on swing, sitting on grass and sitting near corridor. Walking activities included walking, walking while engaging in sports, walking while waiting to partake in a game. And vigorous activities included running, swinging, climbing, playing soccer and basketball and jumping rope (Table 1, Figure D).

Time Dependent Changes in Physical Activity over 3 months and Analysed with Addition of the Animator and Without

Correlation of the scans progression and levels of activity were found significant with the addition of the project/ animator; sedentary activity is shown to negatively correlate ($r= -0.22$, $p<0.0001$), and walking to positively correlate with the scans progression ($r=0.26$, $p<0.0001$). Active showed a downward slope in scans progression as well ($r=-0.32$, $p<0.0001$). Similarly, when the scans were taken without the animator's dedication we see similar results (Table 2, Figure E).

Changes in Median Levels of Activity when Scans are Divided Sequentially

We divided the scan progression sequentially in order of time when scan was taken and found significant increases (walking activity) and decreases (active and sedentary) in the median values for activity indicating a shift in the number of children completing certain levels of activity over time (Table 3). Bar graphs of each of the groups are shown in the figures (Figure F).

Contextual Variable Analysis; average level of engagement of children related to contexts independent of area

The contextual variables analysed in this study were the presence of a *supervisor (*including animator, monitor or a teacher directly adjacent to areas), the *organisation* of an activity that is scheduled with leadership or intramural or interscholastic activity, and the *provision of equipment* (equipment was provided daily by the animator, and some equipment was made available by the school not including permanent facilities such as basketball nets) (ALR ; Colabianchi, Kinsella et al. 2009). All areas were found to be usable and accessible therefore we did not analyze this context even though it was found on the SOPLAY form.

Considering the average or mean number of children engaged in activity of a certain level (i.e sedentary, active, or walking) and pre-determined as having the presence of the context or not during an observational scan in all areas of the playground (without subdividing into areas), all contextual variables, during the entirety of the study were shown to be positively associated with the activity levels of walking and active (Table 4).

However, inactivity (sedentary) did not show a significant association with the presence of all measured variables between the presence of the context and without the context. Therefore, inactivity (sedentary) is not associated with being organized, supervised or equipped in this population. Vigorous (active) physical activity and walking were shown to be engaged in to a greater extent when the

child was directly supervised or when they had a piece of equipment such as a ball, jump rope, hula hoop etc.

Whether the effect of the variables was a motivating factor in activity is to be considered. The contextual variables noted are not associated with sedentary behaviour. Perhaps sedentary children are adverse to monitors (staff) and the provision of equipment due to unknown factors. We also do not know the direction of the association; it cannot be determined whether the presence of the context was a consequence of children being active or walking or whether it was a motivator for such activity.

The associations between contextual variables and activity levels were tested at a significance level of $p<0.05$. Non-parametric Mann Whitney t-test determined significant differences between activity levels with the context and without in order to determine the context relevance to physical activity. Bar graphs in the following figures represent the associations (Figure G).

Temperature Effects

The temperature recording at beginning of scans each day during the observation ranged from very warm to extremely cold (25 °C to -4°C). The higher temperatures were associated with more children displaying either vigorous physical activity or sedentary activity. Walking activity was lower in warmer temperatures. Sedentary (inactivity) was shown to be positively correlated with temperature increases($r=0.18$), walking activity was shown to be negatively correlated with temperature increases ($r=-0.25$) and active (vigorous) activity is shown to positively correlate with temperature increases ($r=0.23$). Correlations were significant at $\alpha=0.05$ (Table 5). Observations were based on a temperature range of -4 degrees Celsius to 25 degrees Celsius which were seasonal temperatures for the observation period of September to December 2011. See graphs in following pages showing the linear association of temperature and physical activity (Figure H).

Grade Based Observations

Children are coded as cycle 1&2 or cycle 3 in order to differentiate between the younger grades and older. Grades observed in this study were 1-6, and cycle 1&2 refers to the younger grades and cycle 3 to older grades. We did not observe significant differences among cycles for average number of children playing when the animator is present vs. when she was not (Table 6).

Area Trends in Relation to the Project Playground

Areas were coded during the observations. Appendix D offers a map of the playground. In total the playground offered 7 distinct areas in order for children to engage in activity (Table 7). All areas were populated by the children; however some areas were more densely populated and were associated with different levels of activity. Area 3 which represents the cemented area showed higher proportions of active and walking. Area 5 is also observed to be associated with a very low level of physical inactivity (Figure I) (Figure J).

Field-note Observations; Barriers to PA

Field-notes recorded were used to identify barriers to the physical activity, and health atmosphere of the school with the intention to improve the physical activity/health environment.

Initial observations of negative behaviours include name calling which included some weight based teasing such as “fat pig” etc. Some minor arguments or fights occurred as did some more serious fights. It was observed that there was

a lack of disciplinary action taken for name calling, yet minor incidents had “time out” and then more serious fights were referred to a student counselor.

The outdoor playground was sometimes littered with broken glass etc. And it was also observed that visitors were allowed on the playground.

A lot of snacking was observed pre recess and also during recess and sometimes these were not healthy choices (Table 8 ,Table 9). Perhaps an elimination of products high in sodium such as chips could be eliminated.

Table 1: Average number of children engaged in sedentary, walking and active levels of activity during 3 months of observation during intervention and non-interventions days.

	Sedentary activity ᾱ(SD)	**%Sedentary**	**Walking activity ᾱ(SD)**	**%Walking**	**Active ᾱ(SD)**	**%Active**
Children in observational scan in total n=1361	0.49(1.21)	4.58	7.22(6.96)	67.83	2.94(4.38)	27.56
Children in observational scan with animator n=643	0.51(1.21)	4.68	7.22(6.93)	66.34	3.15(4.69)	28.97
Children in observational scan w/out animator n=718	0.47(1.21)	4.48	7.23(7)	69.21	2.75(4.08)	26.30

D)

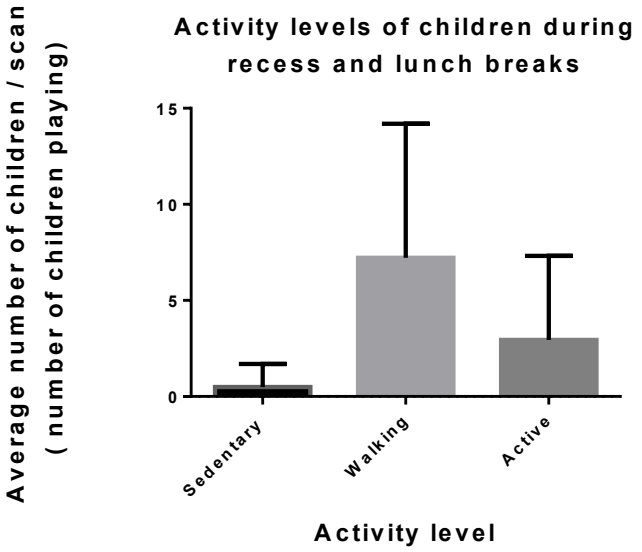
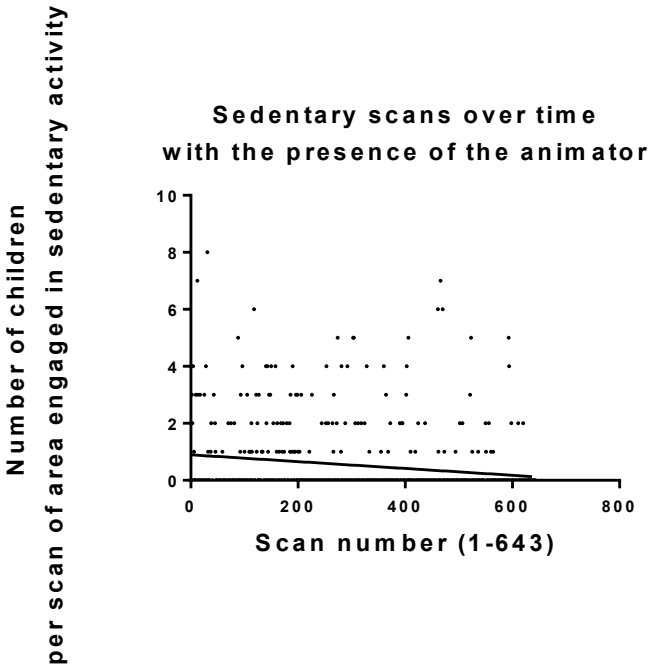
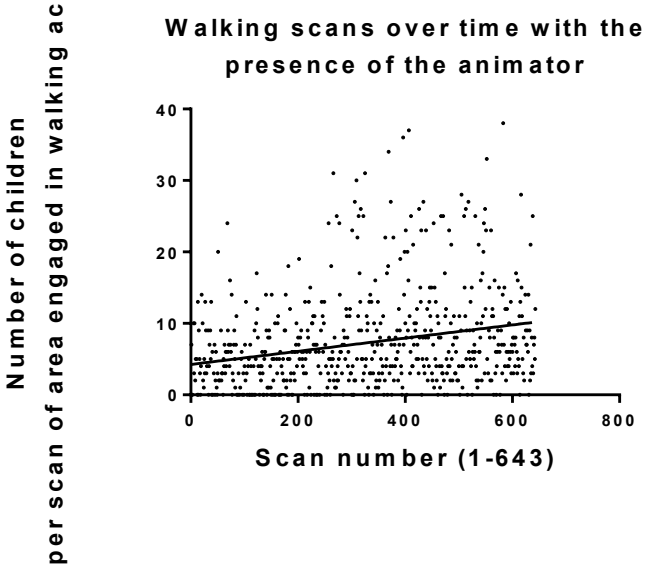

Activity levels of children during recess and lunch breaks
Average number of children / scan (number of children playing)
15
10
5
0
Sedentary
Walking
Active
Activity level

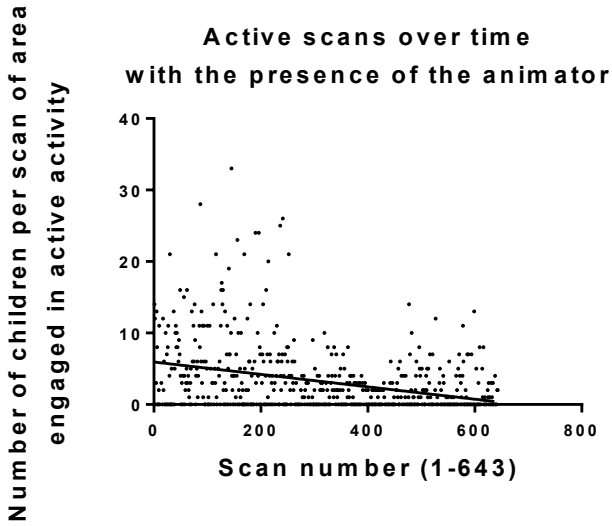
Table 2: Passage of time association with activity

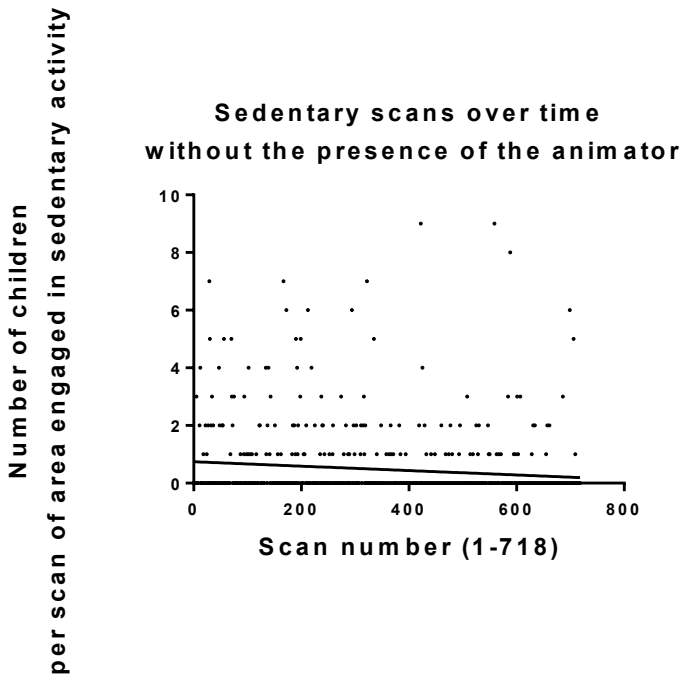
	Spearmen Correlation coefficient (R, 95%C.I) (p-value)
Sedentary with animator	-0.22 , (-0.30 to -0.14) ($p<0.0001$)
Sedentary without animator	-0.15 , (-0.23 to -0.08) ($p<0.0001$)
Walking with animator	0.26, (0.19 to0.34) ($p<0.0001$)
Walking without animator	0.23 (0.16 to 0.30) ($p<0.0001$)
Active with animator	-0.33(-0.40 to-0.25) ($p<0.0001$)
Active without animator	-0.23(-0.31 to -0.16) ($p<0.0001$)

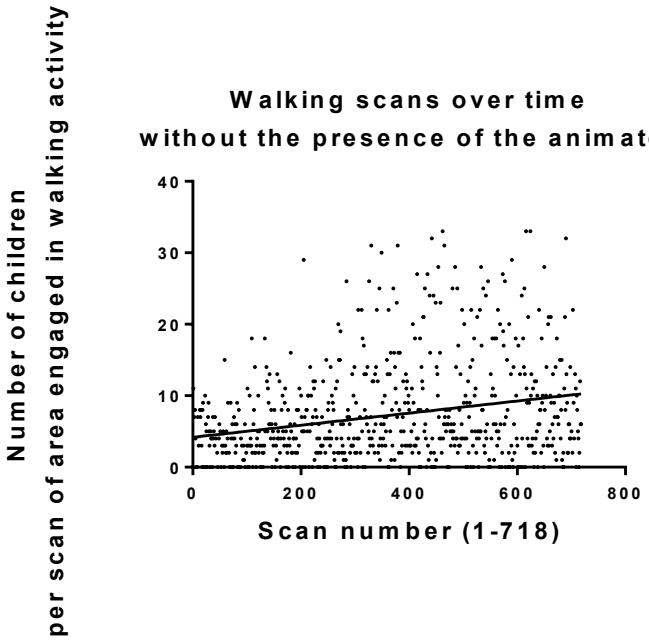
E)


Sedentary scans over time
with the presence of the animator
Number of children
per scan of area engaged in sedentary activity
10
8
6
4
2
0
0
200
400
600
800
Scan number (1-643)


Walking scans over time with the
presence of the animator
Number of children
per scan of area engaged in walking activity
40
30
20
10
0
0
200
400
600
800
Scan number (1-643)


Active scans over time
with the presence of the animator
Number of children per scan of area
engaged in active activity
40
30
20
10
0
0
200
400
600
800
Scan number (1-643)


Sedentary scans over time
without the presence of the animator
Number of children
per scan of area engaged in sedentary activity
10
8
6
4
2
0
0
200
400
600
800
Scan number (1-718)


Walking scans over time
without the presence of the animator
Number of children
per scan of area engaged in walking activity
40
30
20
10
0
0
200
400
600
800
Scan number (1-718)

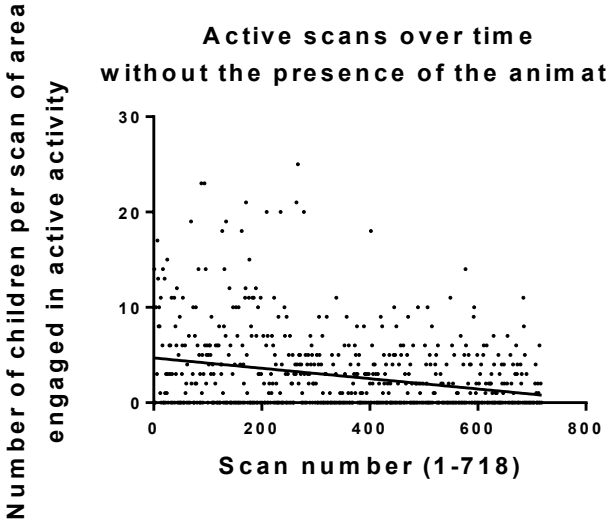
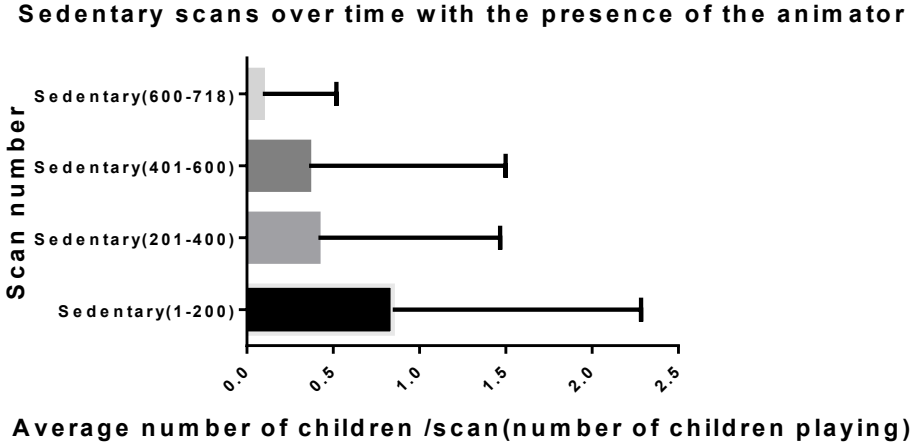
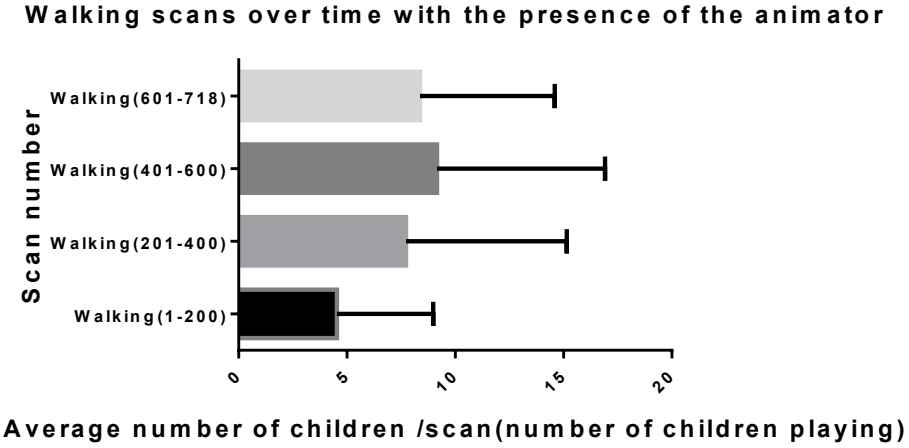

Active scans over time
without the presence of the animator
Number of children per scan of area
engaged in active activity
30
20
10
0
0
200
400
600
800
Scan number (1-718)

Table 3: Average number of children in levels of activity during scan, as time (scans) progressed throughout the study.

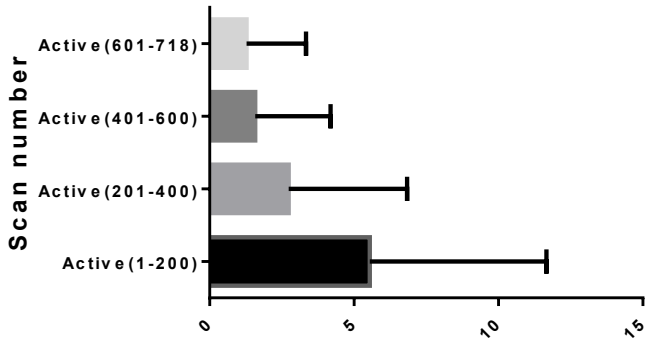
	Average number of children per scan					
	Sedentary		**Walking**		**Active**	
	Addition of project	Without	Addition of project	Without	Addition of project	Without
Scan 1-200	0.85	0.73	4.54	4.35	5.55	4.44
Scan 201-400	0.42	0.44	7.74	7.47	2.74	2.65
Scan 401-600	0.36	0.35	9.16	9.03	1.58	1.93
Scan 600-718	0.09	0.27	8.37	8.64	1.28	1.33
P value ANOVA – Kruskal Wallis (*p<0.05)	<0.0001*	0.0003*	<0.0001*	<0.0001*	<0.0001*	<0.0001*

F)


Sedentary scans over time with the presence of the animator
Scan number
Sedentary(600-718)
Sedentary(401-600)
Sedentary(201-400)
Sedentary(1-200)
0.0
0.5
1.0
1.5
2.0
2.5
Average number of children /scan(number of children playing)

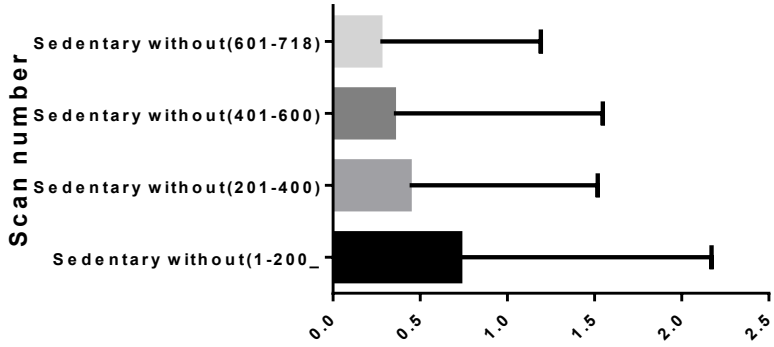

Walking scans over time with the presence of the animator
Scan number
Walking(601-718)
Walking(401-600)
Walking(201-400)
Walking(1-200)
0
5
10
15
20
Average number of children /scan(number of children playing)

Active scans over time with the presence of the animator



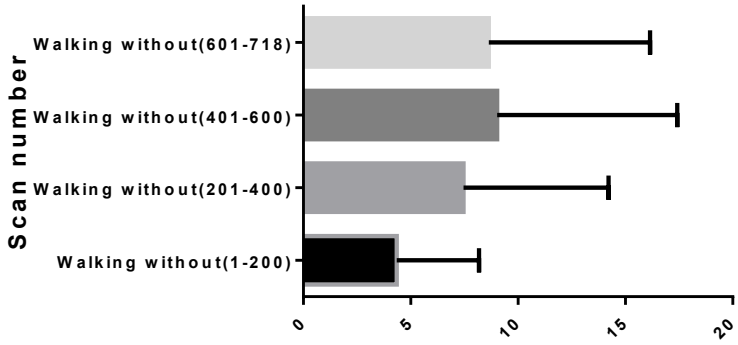
Average number of children /scan(number of children playing)

Sedentary scans over time without the presence of the animator



Average number of children /scan(number of children playing)

Walking scans over time without the presence of the animator



Average number of children /scan(number of children playing)

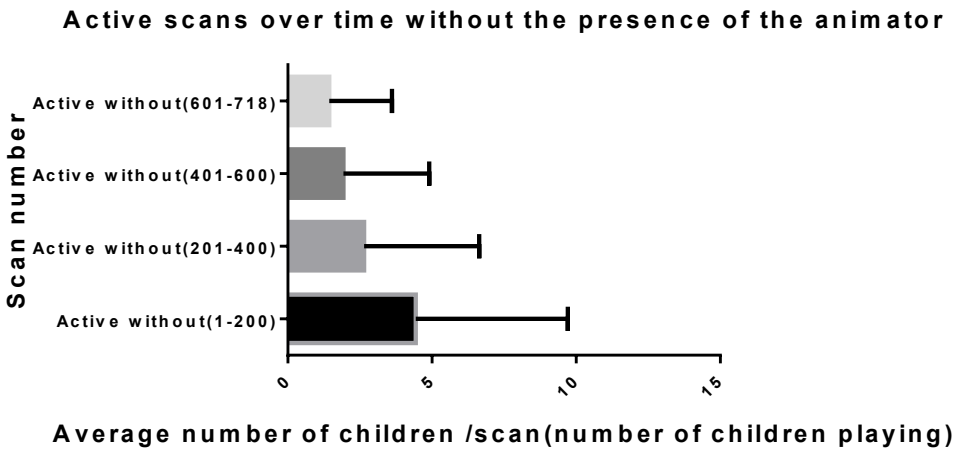
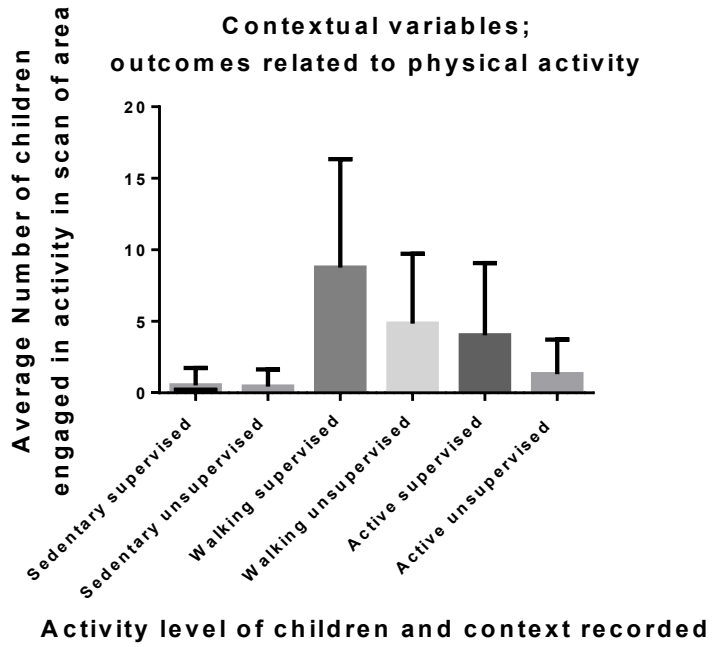
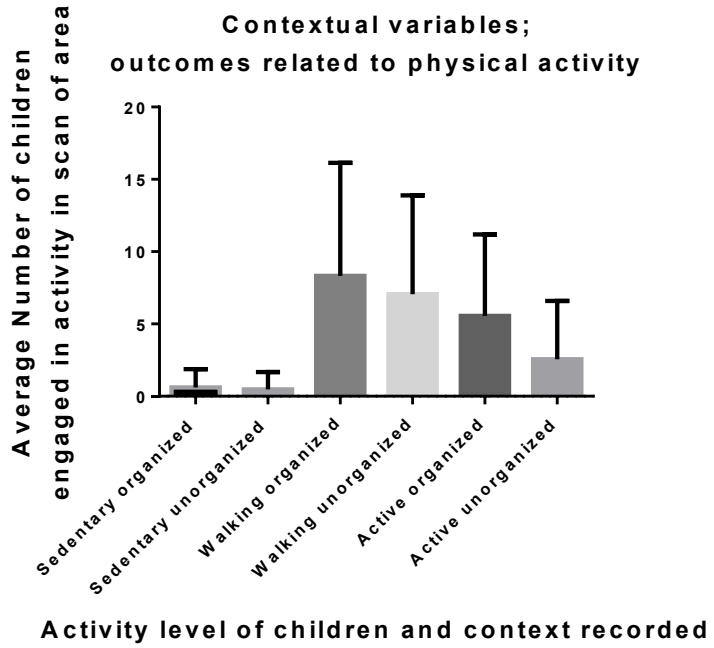

Active scans over time without the presence of the animator
Scan number
Active without(601-718)
Active without(401-600)
Active without(201-400)
Active without(1-200)
0
5
10
15
Average number of children /scan(number of children playing)

Table 4: Mean number of children engaged in various levels of activity and their relation to the presence of the context (supervised, equipped, and organized)

	N (number of scans during context)	**Average(ᾱ) #of children engaged in activity (sedentary, walking, active)**	**p-value sedentary**	**p-value walking**	**p-value active**
Supervised	806	0.51,8.76,4.02	0.1487	<0.0001*	<0.0001*
Unsupervised	549	0.44, 4.84,1.31			
Equipped	536	0.42,9.19,4.78	0.3645	<0.0001*	<0.0001*
Not equipped	825	0.53,5.94,1.74			
Organized	173	0.61,8.32,5.56	0.0535	0.048*	<0.0001*
Not organized	1188	0.46,7.06,2.55			
***p<0.05 t-test**					

G)


Contextual variables;
outcomes related to physical activity
Average Number of children engaged in activity in scan of area
20
15
10
5
0
Sedentary supervised
Sedentary unsupervised
Walking supervised
Walking unsupervised
Active supervised
Active unsupervised
Activity level of children and context recorded


Contextual variables;
outcomes related to physical activity
Average Number of children engaged in activity in scan of area
20
15
10
5
0
Sedentary organized
Sedentary unorganized
Walking organized
Walking unorganized
Active organized
Active unorganized
Activity level of children and context recorded

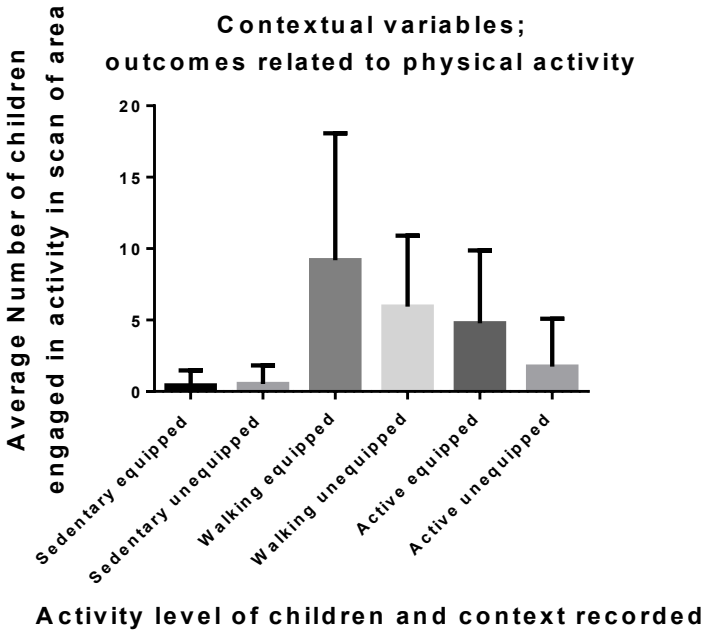
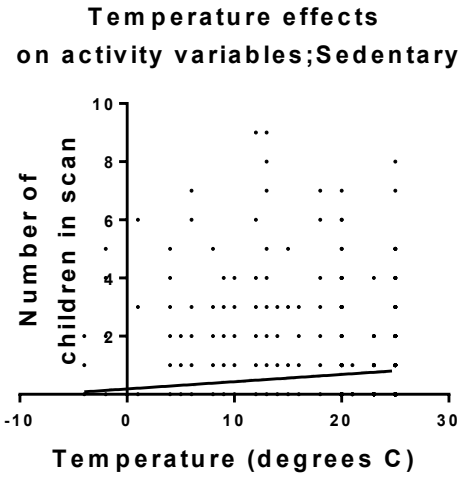
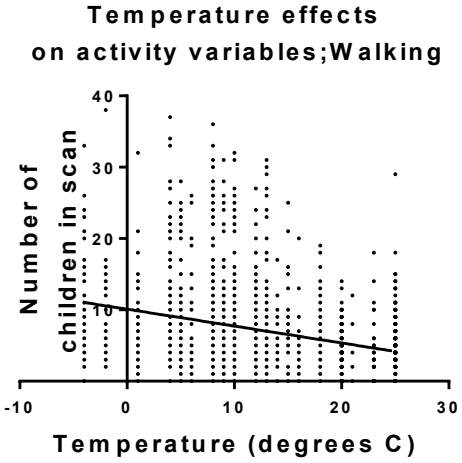

Contextual variables;
outcomes related to physical activity
Average Number of children engaged in activity in scan of area
20
15
10
5
0
Sedentary equipped
Sedentary unequipped
Walking equipped
Walking unequipped
Active equipped
Active unequipped
Activity level of children and context recorded

Table 5: The Relation of temperature increases with the number of children engaged in various activities.

	Spearmen Correlation coefficient (Spearmen R, 95%C.I) (p-value)	
Sedentary activity	0.18 (0.13 to 0.24)	(P<0.0001)
Walking activity	-0.25 (-0.30 to -0.20)	(P<0.0001)
Active activity	0.23 (0.18 to 0.28)	(P<0.0001)

H)


Temperature effects
on activity variables;Sedentary
Number of
children in scan
10
8
6
4
2
-10
0
10
20
30
Temperature (degrees C)


Temperature effects
on activity variables;Walking
Number of
children in scan
40
30
20
10
-10
0
10
20
30
Temperature (degrees C)

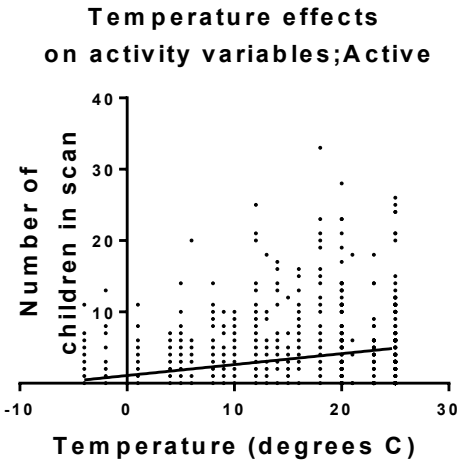

Temperature effects
on activity variables;Active
Number of
children in scan
40
30
20
10
-10
0
10
20
30
Temperature (degrees C)

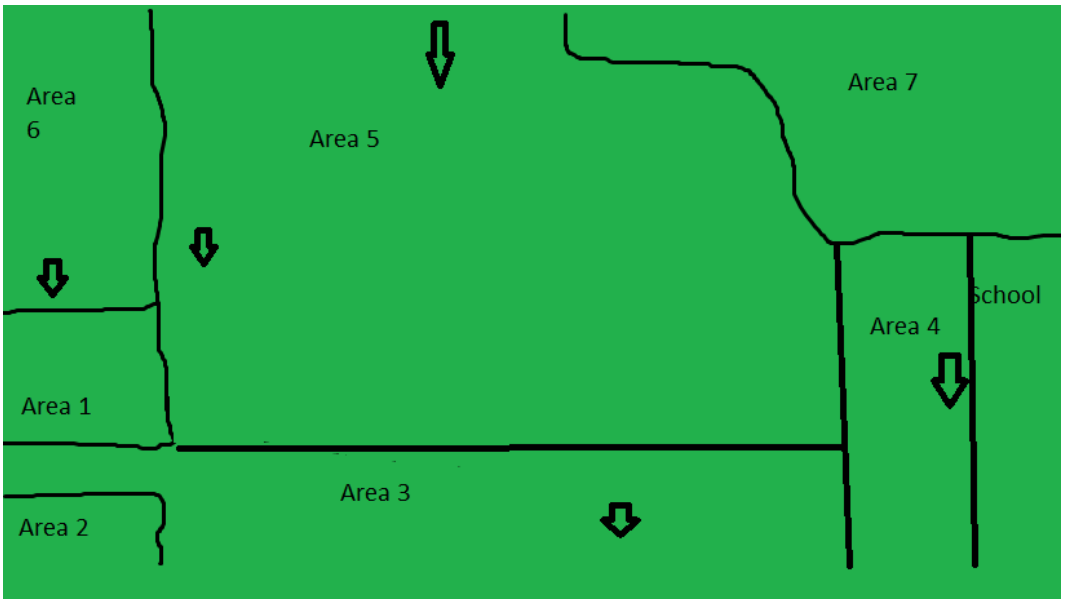
Table 6: Average number of children engaged in activity during intervention and non-intervention days based on differing cycles of grades.

Scans and average number of children engaged in activity	**Cycle 1&2**	**Cycle 3**
	Intervention	
N(number of scans)	396	247
Sedentary (ᾱ ± s.d)	0.54, ±1.16	0.46,±1.29
Walking (ᾱ ± s.d)	7.61, ±6.57	6.59, ±7.45
Active (ᾱ ± s.d)	3.35,±4.56	2.85,±4.9
	Non Intervention	
N	439	279
Sedentary(ᾱ ± s.d)	0.55, ±1.33	0.34,±0.98
Walking(ᾱ ± -s.d)	7.46, ±6.4	6.85,±7.86
Active(ᾱ ± s.d)	2.93,±3.89	2.46,±4.36
P<0.05*		

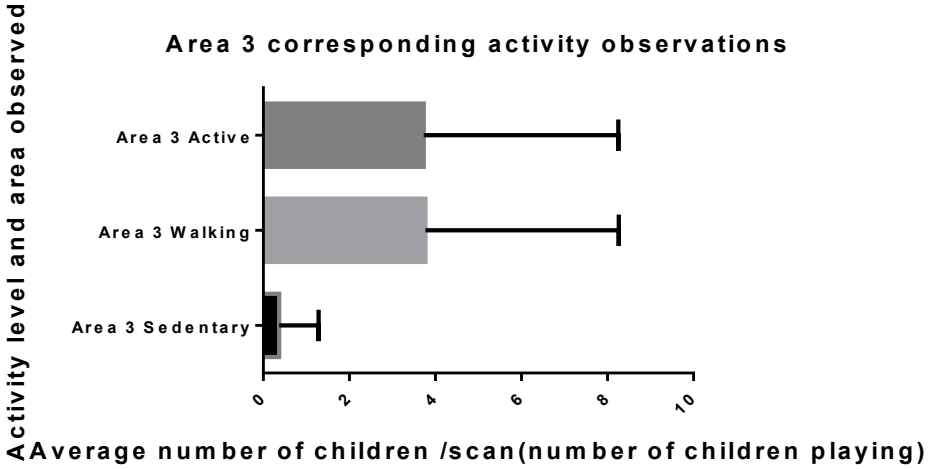
Table 7: A Table corresponding to the mapped location of the schoolyard and the area labels and the location represented

Area	**Location**
1	Jungle gym (outdoor)
2	Jungle gym(pre-school)
3	Court area (basketball nets)
4	Cement area
5	Field (middle)
6	Swings
7	Field(perimeter)

I)



J)


Area 3 corresponding activity observations
Area 3 Active
Area 3 Walking
Area 3 Sedentary
0
2
4
6
8
10
Activity level and area observed
Average number of children /scan(number of children playing)

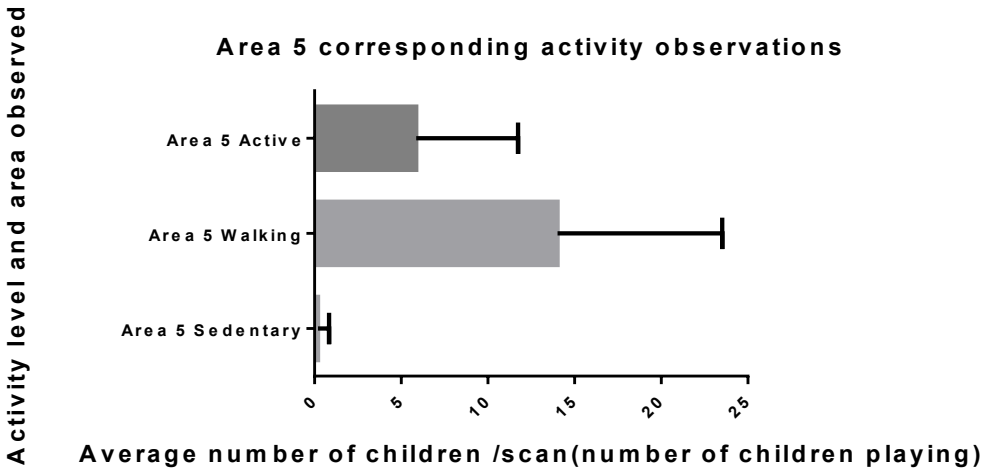

Area 5 corresponding activity observations
Area 5 Active
Area 5 Walking
Area 5 Sedentary
0
5
10
15
20
25
Activity level and area observed
Average number of children /scan(number of children playing)

Table 8: Field note observations

Date	Observation	Comment
Sept 14th	Rain; time spent indoors with board games. Chips of several varieties of baked chips and Cheetos, muffins and boxes of popcorn for sale in cafeteria at recess and lunch.	Rec animator reports she observed broken beer glass in the playground
Sept 19th	Purchasing of snacks for recess at cafeteria. Observed eating these snacks outside at recess and eat either while walking, standing in the corridor.	Name calling
Sept 20th	Tag games result in wrestling and are discouraged by monitors. Exclusion among girls with jump rope games observed with cycle 1/2. Women with baby visiting the playground and kids will hold/play with baby. Seen several times.	

Continued

Date	Observation	Comment
Sept 21st	Increased bullying without animator, less sideliners or lonely individuals. Seems as if bullying encourages PA, inclusion increases momentarily.	Girls report to animator they are not active because they just "do gym". Name calling observed-
Sept 22	Rock for "time outs"	
Sept 26	New rec. helper increased activity in Area 3. Women with baby visiting the playground and kids will hold/play with baby	Name calling
Sept 28	Cycle 1 fight boys in area 1, personal visit to "peace" or "skenenkowa" room.	
Oct 4th		Name calling
October 13	Children ask for balls as well as to open the equipment room	

Table 9: Snacks

Snack	Total fat g	Fiber g	Sodium mg	Energy (kcal) or calories
Cheese puffs, low fat (25g)	3.07	2.7	326	110
Snacks, sun chips, harvest cheddar flavour (28g)	6.22	2.27	151	137
Muffin, dry mix, prepared, blueberry	3.92	Negligible	184	127
Carrot, 50g , 1 small carrot (14cm long)	0.12	1.2	34	20
Apple ,raw, 1 medium fruit	0.24	2.6	1	72
Raisins golden seedless (37g)	0.17	1.5	4	111

Discussion

Assessing the Activity Levels

Recess and lunchtime breaks offered the children plenty of opportunities to engage in various forms of activity. If combined, our walking and active scans yield a much higher proportion of the children in scans compared to sedentary activity. Other studies using the SOPLAY method in schools during break times report a much higher level of sedentary activity. Willenberg et al stated that 44% percent of elementary children were observed participating in sedentary activity, while Mckenzie et al found that 36.8% of the elementary school students assessed in their study were found to be engaged in sedentary activity during scans (McKenzie, Crespo et al. 2010; Willenberg, Ashbolt et al. 2010). These studies, unlike ours, did not include an intervention actively being applied or were taken during baseline measures of school based interventions. The provision of extra playground equipment, similar to the study completed by Verstraete et al which observed increases in MVPA and moderate activity during recess and lunch after providing game equipment and instruction to intervention groups , in our study were shown to be associated with increased levels of walking and active (Verstraete 2006). This is also reflected in our analysis of contextual conditions; the presence of a supervisor and equipment provision are found to significantly associate with increased MVPA.

We did not observe significant differences between intervention and non-intervention days overall on average for number of children engaged in activity; however progressively over time walking activity observed during scans increased. The decline in active activity over time demonstrates a need for improved methods of engaging the children in games etc. suited for the changing weather conditions in order to maintain vigorous activities during the winter. Certain techniques typically are employed to change physical activity behaviour, and perhaps the limited resources applied in this intervention demonstrate the lack of significant behaviour change. Though, obviously a school setting accounts for much of the difficulty implementing a thorough intervention. Perhaps a research

gap exists in this area; for example how do we incorporate the behaviour change tasks needed in schools? And as noted by Scarpa et al, peer victimization leads to decreased positive enjoyment and negative experiences of leisure time physical activity in children; a quantitative analysis to thoroughly assessed qualitative studies.

Wolff and Fitzhugh examined the effects of temperature and weather on the level of trail usage on an urban greenway; and reported that there exists a curvilinear association between step counts on the trail and temperature and that summer months yield greater step counts than winter months. In our study, the children's level of active activity was not sustained throughout the study perhaps due to the fact that the animator was effective at mobilizing children into a walking level of PA. And as a consequence of poor weather conditions; the children will naturally opt to engage themselves into activity organized by the animator (Wolff and Fitzhugh 2011). An indoor option for recess and lunch breaks during cold months of the year could be a useful idea for the augmentation of positive activity levels. More traditional cultural games offered could be effective as well at promoting more active levels of activity.

Snacks

Field-notes in this study provided an atmospheric picture of the day to day of the children during recess and lunch as well as moments immediately prior. Snack buying and snacking were observed. Positive healthy snacking was observed yet for the purposes of health promotion the results implicated the need for snack revision as a lot of purchased snacks were particularly high in sodium. Processed snacks were observed to be for sale and are always much higher in sodium. However, it was also observed that a lot of children bring snacks etc. from homes which are of good nutritional quality such as fresh fruit etc.

Negative Behaviours Observed in Students During Break Periods Associated with P.A.

A counseling resource exists entitled the "peace" or "skenen:kowa" room which children are required to participate in if engaged in negative behaviours of a certain magnitude but often do not account for name calling and teasing. As a physical activity policy is currently being implemented it would be beneficial to address the roles of the outside monitors as well or to enhance this area where needed. Opportunity exists to incorporate new initiatives to address PA at recess and lunch taking into account the needs of students. At present and of particular importance, it was noted that ensuring the safety of the children above all was the most important role of the outside monitor and the promotion of physical activity is not a high priority and sometimes will be stopped in order to ensure a safe break time. However there are definite limitations to our study; the study is quantitative in nature and we did not speak to students directly in order to understand these factors from their perspective. Feasibly a questionnaire assessing students feeling related to victimization can be used in future studies.

Conclusion

It is possible that most of the children in this study receive enough activity per day at school to meet the 60 minute per day quota of moderate physical activity during the duration of the 20 minute recess and 1 hr. lunch breaks at the lower end of the physical activity spectrum. And as bone strengthening activities were not assessed we do not have solid data to make a conclusion, however future research is warranted in this area.

Some recommendations would be to address bullying through guaranteeing outdoor break times are not conducive to negative behaviours as discovered, and to ensure that grounds are always safe for playing through clean ups etc.

We also conclude the presence of an animator is associated with increases in walking levels of activity throughout the study however declines in active

activity demonstrate the need to sustain active activity through the year by means of other methods etc. There was also no differences between physical activity levels on days with the animator, and without the presence of the animator. It can be concluded that the resources needed to significantly improve and sustain physical activity are numerous and the most effective methods of doing so warrant further research. Our analysis of contextual variables offers some valuable insight into this phenomenon.

Our observations indicate that further improvements in the level of activity at school may be attained by offering equipment, supervision and organization. And certain ecological zones such as open field space are a popular area for moderate to vigorous physical activity. During the colder periods, fewer children were active or completely sedentary, indicating a greater challenge for activities involving vigorous activity. The presence of the animator appears to be effective in engaging children in moderate activity and to also sustain and improve this activity throughout the project and subsequent climate changes as well though not significantly different from days when the animator was not employed. However in order to prevent declines in vigorous (active) activity over time or when the weather becomes cold, new approaches will be required to effectively ensure kids remain active at school.

This study covered a variety of factors affecting physical activity at school, and improves upon research gaps pertaining to physical activity research with children. This study examines physical activity levels of children in early years; it also contributes to research completed in an outdoor setting. This study also contributes to the knowledge that organized activity is associated with moderate to vigorous physical activity completed in children. We also examined peer influence on physical activity in a school based setting, and gives data on usage rates of facilities in the playground(AHKC 2012).

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Appendix A: SOPLAY observation form

School ID : ___ ___
Date:__ __/__ __/__ __
D8 D9 D10 D11

SOPLAY

(System for Observing Play and Leisure Activity in Youth)

Obs. ID #: ___ ___ Reliability: 0. No 1. Yes Temp: ___ ___F Period: **1.** BS **2.** L1s1 L1s2 **3.** L2s1 L2s2 **4.** L3s1 L3s2 **5.** AS1 **6.** AS2 **7.** AS3

START TIME	AREA	CONDITION					GIRLS				BOYS			
		A	U	S	O	E	S	W	V	Act.	S	W	V	Act.
__ __: __ __	**1**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**2**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**3**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**4**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**5**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**6**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**7**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____
__ __: __ __	**8**	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	0. N 1. Y	____	____	____	____	____	____	____	____

Activity Codes: 0=No identifiable activity 1=Aerobics 2=Baseball/Softball 3=Basketball 4=Dance 5=Football 6=Gymnastics 7=Martial Arts
8=Racquet sports 9=Soccer 10=Swimming 11=Volleyball 12=Weight Training 13=Other playground games 14=None of the above

SOPLAY Recording Form 1/10/06 SJM

Appendix B: Physical Activity codes for young children

Alternative codes for younger children;

Alternative physical activity codes for young children:

0. no specific activity (sit, stand, walk)
1. fitness/aerobics (dance/step aerobics)
2. baseball/softball
3. basketball/volleyball
4. dance/gymnastics
5. soccer/football
6. climbing/sliding
7. jumping games
8. manipulative games/racquet activities
9. sedentary games/activities
10. none of the other ten categories
11. tag/chasing games

Appendix C: SOPLAY Protocols

SOPLAY Protocols

Observation areas

- Direct observations will be made in designated target areas that represent all standard target locations likely to provide opportunities for students to be physically active.
- A map is provided to identify areas
- Target areas may be divided into smaller scan spaces during periods of high student density

Observation preparation

- Prepare equipment: wristwatches, counter, clipboard, sufficient SOPLAY recording forms and pencils
- Arrive at site 60 minutes early. Review target areas and prepare mentally for scanning.

SOPLAY Codes and Recording

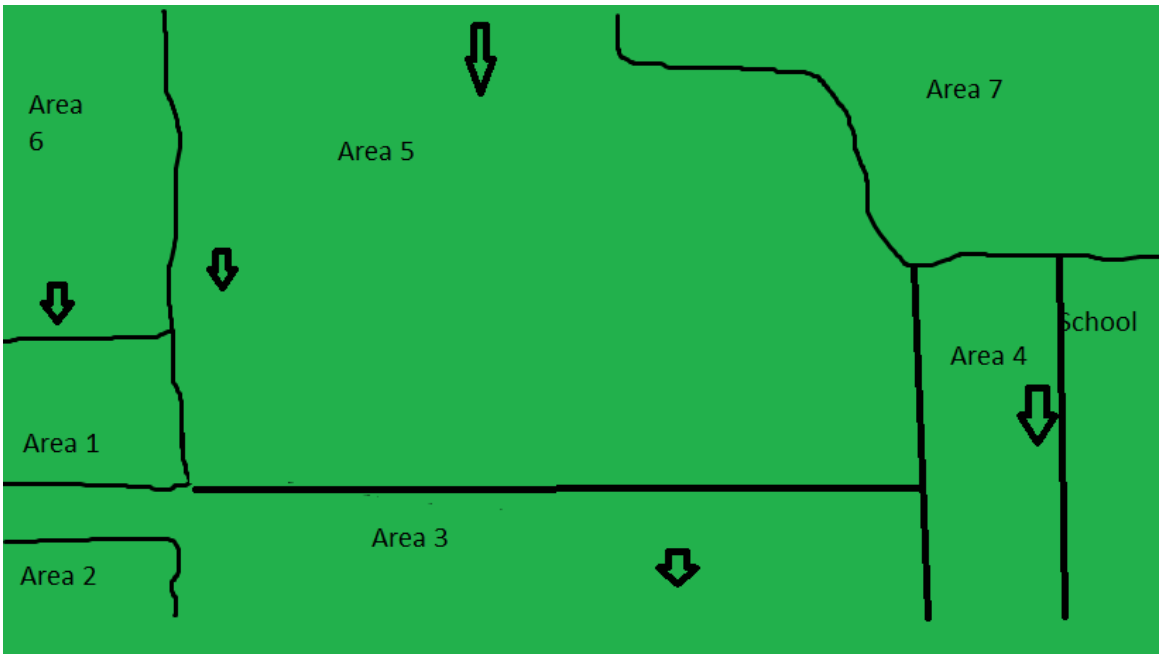
- Reliability (y/n for assurance measures)
- Temperature
- Period of break (lunch, recess)
- Start time (of sweep of area)
- Area (of previously designated area)
- Condition (A, U or S or N, O,E) A= accessible area, U= areas is usable for physical activity (not wet or dirty), S= area is supervised, O= Organized activity, E= equipment provided
- Strength (SWV, sedentary, walking, or very active)
- Activity code: see appendix B.

Appendix C: Recording Procedures

Recording Procedures

- On observation form enter the School ID, the date, observer id, temperature, and period of assessment.
- Enter start time for the scan space
- Record contextual variables
- Scan entire area for girls using mechanical counter to record the # of girls engage is sedentary, walking, and very active observations. Classify the predominant type of activity occurring. Reset counter and repeat for boys.
- Always scan from left to right

Appendix D: Map indicating areas observed



Legend: Arrow indicating positions of observation points

Appendix E: Behaviour Change Techniques (Michie, Ashford et al. 2011)

Table 10: BCT Taxonomy Michie et al.

1	Provide consequences of behaviour change in general
2	Provide information on consequences of behaviour change to the individual
3	Provide information about others approval
4	Provide normative information about others behaviour
5	Goal setting (behaviour)
6	Goal setting (outcome)
7	Action planning
8	Barrier identification/ problem solving
9	Set graded tasks
10	Prompt review of behavioural goals
11	Prompt review of outcome goals
12	Prompt rewards contingent on effort or progress towards behaviour

Table 10 Continued

13	Provide rewards contingent on successful behaviour
14	Shaping
15	Prompting generalization of a target behaviour
16	Prompt self-monitoring of behaviour
17	Prompt self-monitoring of behavioural outcome
18	Prompting focus on past success
19	Provide feedback on performance
20	Provide information on where and when to perform the behaviour
21	Provide instruction on how to perform the behaviour
22	Model/demonstrate the behaviour
23	Teach to use prompts/ cues
24	Environmental restructuring
25	Agree behavioural contact
26	Prompt practice
27	Use of follow up prompts
28	Facilitate social comparisons

Table 10 Continued

29	Plan social support/ social change
30	Prompt identification of role model/position advocate
31	Prompt anticipated regret
32	Fear arousal
33	Prompt self-talk
34	Prompt use of imagery
35	Relapse prevention/ coping planning
36	Stress management/ emotional control training
37	Motivational interviewing
38	Time management
39	General communications skills training
40	Stimulate anticipation of future rewards