"Monkey see, monkey do": Peers' behaviors predict preschoolers' physical activity and dietary intake in childcare centers

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ABSTRACT

Preschoolers observe and imitate the behaviors of those who are similar to them. Therefore, peers may be important role models for preschoolers' dietary intake and physical activity in childcare centers. This study examined whether peers' behaviors predict change in preschoolers' dietary intake and physical activity in childcare centers over 9 months.

A total of 238 preschoolers (3 to 5 years old) from 23 childcare centers in two Canadian provinces provided data at the beginning (October 2013 and 2014) and the end (June 2014 and 2015) of a 9-month period for this longitudinal study. Dietary intake was collected at lunch using weighed plate waste and digital photography on two consecutive weekdays. Physical activity was assessed using accelerometers over five days. Multilevel linear regressions were used to estimate the influence of peers' behaviors on preschoolers' change in dietary intake and physical activity over 9 months.

Results showed that preschoolers whose dietary intake or physical activity level deviated the most from those of their peers at the beginning of the year demonstrated greater change in their intakes and activity levels over 9 months (all p values<0.05), which enabled them to become more similar to their peers.

This study suggests that preschoolers' dietary intake and physical activity may be influenced by the behaviors of their peers in childcare centers. Since peers could play an important role in promoting healthy eating behaviors and physical activity in childcare centers, future studies should test interventions based on positive role modeling by children.

INTRODUCTION

Establishing healthy eating and physical activity behaviors in childhood is important as these can persist into adulthood (Bélanger et al., 2015; Mikkilä et al., 2005). Previous studies have focused on parents as agents for healthy eating and physical activity in preschoolers (Beydoun and Wang, 2009; Zecevic et al., 2010). However, childcare centers have been identified as potential key locations for the promotion of healthy eating behaviors and physical activity as approximately 80% of preschoolers (2 to 5 years old) living in developed countries receive out-of-home care (Organisation for Economic Co-operation and Development, 2013), and spend a considerable amount of their waking hours in childcare centers. For example, 70% of Canadian parents who use childcare services for their children under the age of 4 report using them for at least 30 hours a week (Sinha and Bleakney, 2014).

Childcare centers offer many opportunities for children to develop both healthy eating behaviors and physical activity. Children who attend childcare centers on a full-time basis are generally offered lunch and snacks, which can contribute to their daily nutritional requirements (Benjamin Neelon et al., 2011). United States benchmarks for nutrition have suggested that half to two-thirds of children's nutritional needs should be met while in childcare (Benjamin Neelon et al., 2011). However, many preschoolers consume low amounts of vegetables and fruit, and excessive amounts of saturated fat and added sugars while in childcare centers (Ball et al., 2008; Copeland et al., 2013; Erinosho et al., 2013; Gubbels et al., 2014). Furthermore, despite opportunities for children to be active inside and outside, studies have consistently shown that sedentary time within childcare centers is typically high, while physical activity levels are typically very low, accumulating less than 20 minutes per day of moderate-to-vigorous physical activity (MVPA) during an 8-hour day (Kuzik et al., 2015).

Bandura's theory of observational learning suggests that children can learn new behaviors, or increase or decrease the frequency of a previous behavior by observing, remembering and replicating the behaviors of those around them (Bandura, 1977). Furthermore, it is suggested that children will be more likely to replicate the behavior of someone who they like, respect or who they perceive as similar to themselves (Bandura, 1977). Therefore, preschoolers' eating and physical activity behaviors may be shaped by imitating those of their peers while in childcare

centers. However, a recent systematic review concluded that current evidence of a potential relationship between preschoolers' food intake or physical activity, and that of their peers is based on small controlled experimental research, cross sectional observations, and small pre-post studies (Ward et al., 2016). This review also highlighted the need for longitudinal population-based studies to examine how peers influence these behaviors over time, as recent data suggest that it can take up to 8 months for a health-related behavior to be adopted (Lally et al., 2010). Therefore, this study aimed to assess how peers' behaviors predict preschoolers' dietary intake and physical activity in childcare centers, over the course of 9 months.

METHODS

Subjects

Participants in the Healthy Start – Départ Santé (HSDS) intervention, a clustered randomized controlled trial conducted over a 9-month period in New Brunswick and Saskatchewan, provided data for this longitudinal study (Bélanger et al., 2016). All preschoolers (3 to 5 years) attending the childcare center on a full-time basis were eligible to participate in the study. Of the 61 childcare centers that were recruited for the HSDS intervention, dietary data from children who attended 17 childcare centers randomized to the control group in the first two years of the study were available at the time of analysis. Valid physical activity data from children attending 22 of the 23 centers randomized to the control group in the first two years of study and were used for the analysis on physical activity. Procedures used to obtain these data are described below. The HSDS study received approval from the Centre Hospitalier de l'Université de Sherbrooke, the University of Saskatchewan, and Health Canada ethics review boards. All parents or guardians of participating children provided signed informed consent.

Outcome assessments

Dietary intake

Children's intake in calories, fiber, sugar, fat, sodium, and fruit and vegetables was assessed at lunch on two consecutive weekdays, at baseline (October 2013 and 2014) and endpoint (9 months later, i.e., June 2014 and 2015, respectively) of the same school year, using weighed plate waste and digital photography. These nutrients were chosen based on reports that Canadian

children frequently consume foods and beverages that are high in calories, sugar, fat and sodium, and consume insufficient amounts of fiber-rich fruit and vegetables (Garriget, 2007; Health Canada, 2012). The decision to collect dietary data on only two days was based on feasibility and on reports from previous studies which have assessed children's dietary data in schools and childcare centers over the same number of days (Ball et al., 2007; Kirks and Wolff, 1985). The weighed plate waste method has shown to be a reliable measurement of dietary intake and has been used in studies among school-aged children (Lee et al., 2001). First, each food item that was offered at lunch on days of data collection was weighed and photographed before and after each serving. This included the main course, sides, beverages and desserts. Second, the difference in weight between the initial serving and the leftovers was calculated to obtain each child's specific dietary intake (Jacko et al., 2007). Third, the recipes of the lunches were entered into a nutritional analysis software, Food Processor (version 10.10.00), to analyze the child's intake in calories, fiber, sugar, fat, sodium, and fruit and vegetables. Pictures were used to validate all data collected and to qualitatively identify the proportion of food items that were served and consumed. The average intake over the course of the two days was then computed for each child. The difference between a child's dietary intake at endpoint and baseline was calculated to reflect the change in dietary intake of the child over the course of 9 months, and was used as the outcome variable for this study.

Physical activity and sedentary activity

Physical activity was assessed using the Actical accelerometer. The Actical has shown to be a valid tool for measuring physical activity levels of preschoolers (Pfeiffer et al., 2006). Children wore the accelerometer on the right hip with an elastic belt during childcare hours for five consecutive weekdays. Educators were required to place the accelerometer on the children when they first arrived at the childcare center, and remove it before they went home. Children were asked to wear the accelerometer during the entire day, including nap time. After the measurement period, the accelerometers were collected and sent to the research staff.

Accelerometer data were recorded in 15 second epochs, and were used to measure time spent in physical activity and sedentary behavior based on predetermined thresholds validated in preschoolers (Pfeiffer et al., 2006). Accelerometer counts of less than 25 counts per 15 seconds

defined sedentary behavior (which would include nap time), while counts between 25 and 714 per 15 seconds defined light intensity physical activity time (LPA). Moderate-to-vigorous physical activity was defined as 715 counts or more per 15 seconds. Non-wear time was defined as at least 60 consecutive minutes of zero counts. Valid days and hours were determined using the study's baseline data, following a statistical method described by Rich et al. (Rich et al., 2013). Specifically, the Spearman-Brown prophecy formula and the intraclass correlation coefficient were used to calculate the reliability coefficients (r) of the mean daily counts/minute and analyses were repeated on data from children who met wear times between one to ten hours (based on typical childcare hours of 7:30 am to 5:30pm), and wear days between one to five (Monday to Friday). Results demonstrated that using a minimum of two hours and four days as valid minimum wear time provided acceptable reliability coefficients (r= 78.6%) while maximizing the number of data collection days and sample size (Figure 1). All children's physical activity data were then standardized to an 8-hour period to control for within and between participant wear time variation (Katapally and Muhajarine, 2014). Raw accelerometer data were cleaned and managed using SAS codes adapted for this study (Bélanger and Boudreau, 2015).

Figure 1 here

Peers' behaviors

For each child, the mean baseline dietary intake and physical activity of all other children in their childcare center was computed (the child's own dietary intake or physical activity was not included). A variable representing the deviation between a child's behavior and his or her peers' was then computed by calculating the difference between the child's and the mean of peers' dietary intake or physical activity at baseline.

Confounding variables

Based on directed acyclic graphs and existing literature, age (American Academy of Pediatrics, 2009; Rice and Trost, 2013), sex (Colley et al., 2011; Garriget, 2007), province (Canadian Fitness & Lifestyle Research Institute, 2011a, 2011b; Health Canada, 2005), rurality (Liu et al., 2012) and the number of preschoolers attending the childcare center were identified as potential confounding variables. The children's age was obtained using parent questionnaires from the HSDS intervention. Rurality of the centers was based on publically available geospatial information from the Community Information Database, 2006 (Government of Canada's Rural Secretariat, 2006). Urban locations were identified as census metropolitan areas (CMAs), census agglomerations (CAs) or strong metropolitan influenced zone (MIZ). Regions that were identified as moderate, weak or no MIZ were considered as rural locations. The total number of preschoolers attending the childcare center was derived from the number of children reported by the director of each center as being eligible for the study.

In order to investigate whether our results could be mediated by the length of time a child had attended the childcare center, parents were asked to provide the month and year their child was enrolled in the current center. Duration of attendance was considered as the time a child had attended center when baseline data collection was obtained.

Statistical analyses

All statistical analyses were conducted in R, version 3.1.1. To predict peers' behaviors on a child's dietary intake and physical activity, bivariate linear regressions were conducted first.

Multilevel linear regression models were then generated to control for the potential confounders and to account for clustering at the level of childcare centers. Finally, sensitivity analyses were conducted to determine whether the length of time a child had attended the childcare center influenced results, by using data from children whose parents returned the completed parent questionnaire. This variable could only be used in sensitivity analyses given it was only available for a small portion of participants. In order to visually represent the data, quintiles of the deviation between participants' and their peers' baseline dietary intake and physical activity were created.

RESULTS

Of the 1205 children eligible to participate in the HSDS intervention in the first two years of the study, consent was obtained from parents of 730 children (61%). Of these children, 350 attended a childcare center that was randomized to the control group (203 children in NB and 147 children in SK). An average of 23 children were enrolled in the preschool program in each of the childcare centers. A total of 238 children (mean age of 4.0 at the beginning of the study) provided data at both time points; 152 children (52.6% boys) provided baseline and endpoint dietary data, while 199 children (51.3% boys) provided valid accelerometer data. Parent reported income showed that 82% of children were living in a household which earned $50 000 or more per year. Age-adjusted BMI, dietary intake and physical activity of the children included in the analyses are presented in Table 1.

Table 1. Age-adjusted BMI, dietary intake and physical activity of participants per day at baseline and endpoint n=238						
	All children n=238		**Boys n=123 (52%)**		**Girls n=115 (48%)**	
	N	**%**	**N**	**%**	**N**	**%**
Age –adjusted BMI at baseline n=229						
Underweight (BMI <18.5)	24	10.5	12	10.2	12	10.8
Healthy weight (BMI 18.5-24.9)	168	73.4	86	72.9	82	73.9
Overweight (BMI 25 – 29.9)	31	13.5	17	14.4	14	12.6
Obese (BMI ≥30)	6	2.6	3	2.5	3	2.7
Age –adjusted BMI at endpoint n=212						
Underweight (BMI <18.5)	12	5.7	5	5.1	7	6.8
Healthy weight (BMI 18.5-24.9)	165	77.8	77	77.8	78	75.7
Overweight (BMI 25 – 29.9)	29	13.7	14	14.1	15	14.6
Obese (BMI ≥30)	6	2.8	3	3.0	3	2.9
	Mean (SD)	**95% CI**	**Mean (SD)**	**95% CI**	**Mean (SD)**	**95% CI**
Dietary intake per day at baseline n=152						
Calories (kcal)	271.4 (103.0)	255.1, 287.8	279.1 (112.0)	254.5, 303.6	263.0 (92.0)	241.7, 284.3
Fiber (g)	2.5 (1.1)	2.3, 2.7	2.6 (1.2)	2.3, 2.9	2.4 (1.0)	2.2, 2.7
Sugar (g)	15.3 (13.6)	13.2, 17.5	16.3 (14.5)	13.1, 19.5	14.3 (12.5)	11.4 (17.1)
Fat (g)	8.3 (3.9)	7.7, 8.9	8.7 (4.1)	7.8, 9.6	7.9 (3.6)	7.1, 8.7
Sodium (mg)	457.0 (234.6)	419.7, 494.3	449.0 (236.7)	397.1, 500.9	465.9 (233.6)	411.9, 519.9
Fruit and vegetables (g)	64.9 (49.0)	57.1, 72.7	67.0 (54.1)	55.1, 78.8	62.6 (43.0)	52.7, 72.6
Dietary intake per day at endpoint						
Calories (kcal)	320.3 (161.6)	294.7, 346.0	323.0 (176.7)	284.3, 361.7	317.4 (144.2)	284.1, 350.7
Fiber (g)	2.9 (1.7)	2.6, 3.2	2.9 (1.8)	2.5, 3.3	2.8 (1.6)	2.5, 3.2
Sugar (g)	18.5 (15.2)	16.1, 21.0	19.3 (14.8)	16.1, 22.6	17.7 (15.8)	14.1, 21.3
Fat (g)	9.8 (6.3)	8.8, 10.8	9.6 (7.0)	8.1, 11.1	10.1 (5.5)	8.8, 11.4
Sodium (mg)	493.9 (376.4)	434.1, 553.8	500.9 (390.6)	415.3, 586.5	486.2 (362.6)	402.5, 570.0
Fruit and vegetables (g)	80.5 (59.7)	71.0, 90.0	86.6 (67.6)	71.8, 101.4	73.6 (49.1)	62.3, 85.0
Physical activity per day at baseline n=199						
Total physical activity (min)	179.2 (49.3)	172.3, 186.0	185.7 (48.3)	176.3, 195.1	172.3 (49.7)	162.4, 182.2
MVPA (min)	11.1 (13.5)	9.2, 13.0	10.5 (8.1)	8.9, 12.0	11.8 (17.4)	8.3, 15.3
LPA (min)	168.0 (45.4)	161.7, 174.4	175.3 (47.4)	166.0, 184.5	160.5 (42.2)	152.1, 168.9
Sedentary time (min)	300.1 (49.3)	294.0, 307.7	294.3 (48.3)	284.9, 303.7	307.7 (49.7)	297.8, 317.6

Physical activity per day at endpoint						
Total physical activity (min)	177.5 (62.1)	168.9, 186.14	183.1 (64.3)	170.6, 195.6	171.7 (59.4)	159.8, 183.5
MVPA (min)	13.9 (11.8)	12.3, 15.5	13.5 (9.8)	11.6, 15.4	14.3 (13.7)	11.5, 17.0
LPA (min)	163.6 (56.1)	155.8, 171.4	169.5 (59.0)	158.1, 181.0	157.4 (52.4)	147.0, 167.8
Sedentary time (min)	300.7 (62.3)	292.1, 309.4	293.4 (64.3)	281.0, 305.9	308.3 (59.4)	296.5, 320.2

LPA is light intensity physical activity.
MVPA is moderate-to-vigorous physical activity.
Time/place of the study: October 2013 and 2014 (baseline), and June 2014 and 2015 (endpoint)/ Saskatchewan and New Brunswick, Canada.

At baseline, children consumed an average of 271 kcal, 2.5g of fiber, 15.3g of sugar, 8.3g fat, 457mg of sodium and 64.9g of fruit and vegetables during lunchtime. Children accumulated an average of 179.2 minutes of total physical activity during childcare hours (22.4 minutes/hour), 6% (11.1 minutes or 1.4 minutes/hour) of which were spent in MVPA. Children spent 63% of their time in childcare being sedentary (300.1 minutes or 37.5 minutes/hour) and 35% in light physical activity (168.0 minutes or 21 minutes/hour). Although children's total physical activity and sedentary time remained relatively unchanged at the end of the year, children's dietary intake of macronutrients increased by 8 to 24% over the 9 months of follow-up.

Results from regression analyses suggest that children whose dietary intake differed greatly from their peers at baseline had dietary intakes that were more similar to that of their peers 9 months later (Figure 2, Panel A). In contrast, there was little change between measurement periods in dietary intake of children who had similar intakes as their peers at baseline. For example, if a child ate 100 calories more than his peers at baseline, that child will have eaten 50 calories less at endpoint ((100 calories more than his peers at baseline) X β = -50 calories) (Table 2). Similarly, if a child ate 10 calories less than his peers at baseline, he will have eaten 5 calories more at endpoint ((-10) X β = 5.02). Results remained significant for all outcomes after adjustment for confounders.

Figure 2 here

Table 2. Association between the deviation in dietary intake and physical activity of children and that of their peers' at baseline, and the difference between the children's own behaviors at baseline and endpoint

Deviation between children's dietary intake and their peers' dietary intake at baseline	**Difference in children's dietary intake between baseline and endpoint**					
	Univariate linear regressions (n=152)		Multilevel linear regressions [a]			
			All children (n= 152)		Sensitivity analyses [b] (n=22)	
	β	95% CI	β	95% CI	β	95% CI
Calories (kcal)	-0.497	-0.764 to -0.229	-0.502	-0.692 to -0.312	0.086	-0.763 to 0.902
Fiber (g)	-0.577	-0.831 to -0.322	-0.583	-0.766 to -0.401	-0.371	-1.026 to -0.054
Sugar (g)	-0.234	-0.463 to -0.004	-0.236	-0.400 to -0.074	0.506	-0.232 to 1.493
Fat (g)	-0.624	-0.918 to -0.329	-0.624	-0.835 to -0.411	0.038	-0.886 to 0.910
Sodium (mg)	-0.595	-0.904 to -0.286	-0.608	-0.809 to -0.408	0.239	-0.720 to 0.854
Fruit and vegetables	-0.599	-0.823 to -0.375	-0.602	-0.764 to -0.440	-0.387	-0.402 to 0.018
Deviation between children's physical activity and their peers' physical activity	**Difference in children's physical activity between baseline and endpoint**					
	Univariate linear regressions (n=199)		Multilevel linear regressions [a]			
			All children (n= 199)		Sensitivity analyses [b] (n=44)	
	β	95% CI	β	95% CI	β	95% CI
Total physical activity (min)	-0.643	-0.816 to -0.471	-0.650	-0.817 to -0.483	-0.652	-0.941 to -0.362
MVPA (min)	-0.625	-0.815 to -0.436	-0.601	-0.783 to -0.419	-0.556	-0.924 to -0.187
LPA (min)	-0.518	-0.682 to -0.355	-0.517	-0.677 to -0.356	-0.558	-0.871 to -0.244
Sedentary time (min)	-0.610	-0.785 to -0.434	-0.621	-0.792 to -0.450	-0.652	-0.941 to -0.362

LPA is light intensity physical activity.
MVPA is moderate-to-vigorous physical activity.
[a] Includes adjustments for province, rurality, age and sex of the child, number of children in the childcare center, and clustering at the level of childcare centers. [b] Sensitivity analyses were conducted using data from children for whom duration of attendance was obtained.
Time/place of the study: October 2013 and 2014 (baseline), and June 2014 and 2015 (endpoint)/ Saskatchewan and New Brunswick, Canada.

Children who differed the most from their peers in terms of physical activity level at the first measurement period displayed greater changes in their physical activity level between the two time points (Table 2). On average, children who had relatively low physical activity levels at the first measurement, increased their physical activity level at the second measurement, whereas children who had relatively high physical activity levels initially, decreased their physical activity level during the same period (Figure 2, Panel B). These results remained unchanged following adjustment for confounders.

Of the 152 children who provided dietary intake data, length of attendance was available from 22 children. At the time of baseline data collection, these children had attended the childcare center for an average of 749 days (2 years), with duration of attendance ranging from 0 to 1219 days. After conducting sensitivity analyses accounting for duration of attendance, regression coefficients remained similar only for fiber and fruit and vegetables. The small sample size most likely precluded the attainment of statistical significance for the estimated effect of differing from peers at baseline on change in intake over 9 months. Duration of attendance was obtained from 44 of the 199 children who provided physical activity data. Mean attendance was 656 days with a range of 0 to 1308 days. Results from sensitivity analyses were similar to those obtained from the total sample of children, suggesting that peers' behaviors contribute to predicting children's physical activity levels regardless of how long they had attended that childcare center.

DISCUSSION

To our knowledge, this is the first study to objectively assess how peer behavior predict change in preschoolers' dietary intake and physical activity peers over time. Results suggest that peers' dietary intake and physical activity predict children's dietary intake and physical activity over a 9-month period. Specifically, the greater the deviation between children's intake or physical activity and those of their peers at the beginning of the year, the more their behavior changed to become more similar to that of their peers over time. Similar to studies that found that peers influenced school-aged children's physical activity over time (Coppinger et al., 2010) and youth's food intake (Salvy et al., 2009), our findings support the theory of observational learning and suggest that peers should be considered as potential role models for healthy eating and physical activity among preschoolers.

Regardless of the quality of the peers' intake, children's dietary intake became similar to their peers' over time. This suggests that if peers have a healthy diet, children whose diet is poor could potentially see improvements over time. However, this hypothesis is contingent on the quality of the foods that are available to children attending childcare centers, and studies have shown that lunches served in childcare centers typically contain low amounts of vegetables and high amounts of added sugars and saturated fat (Erinosho et al., 2013). In order for peers to be role models for healthy eating, healthy foods must be offered by childcare centers or reinforced through nutrition policies when lunch is brought from home.

Our results support previous experimental studies that found that peers influenced children's food choices, preferences and intake (Ward et al., 2016). This finding is promising, particularly in cases where children experience food reluctance (e.g. fussy or picky eaters), a relatively common issue in early childhood (Dubois et al., 2007). As such, peers may be able to inadvertently help these children improve their eating behaviors, especially if childcare educators are able to group food reluctant children with peers who demonstrate positive eating behaviors at the same table at lunch time.

Experimental studies have found that preschoolers were more active when in the presence of one or more peers than when they were alone (Barkley et al., 2014; Eaton and Keats, 1981).

However, these studies were conducted in laboratory settings with small samples of children (n<70), did not assess the physical activity of the peers, and were not designed to assess the impact of those peers on children's physical activity over time (Barkley et al., 2014; Eaton and Keats, 1981). Results from the current study suggests that the degree to which peers are more or less active than others can have an impact on the peers' likelihood of becoming more or less active over time. While additional research is needed to confirm our findings, interventions should consider targeting peers as a method for increasing children's physical activity in childcare centers. Building on a previous study that suggested that engaging support from friends may increase physical activity among adolescent girls (Neumark-Sztainer et al., 2003), less active children could be paired with very active peers during games and activities. The development and testing of such interventions is required as our results highlight the low levels of physical activity observed in childcare centers. Specifically, children in our study spent 63% of the time in childcare in sedentary activity and only 2% in MVPA, which is almost identical to the results of a study of preschoolers in Alberta, Canada, which found that participants spent 62% of their time in sedentary activity and 4% in MVPA (Kuzik et al., 2015).

We questioned whether our findings could be affected by the length of time the child had been exposed to his peers. However, when adjusting for duration of attendance, regression coefficients from sensitivity analyses were similar to those obtained from the main models in the case of physical activity. Although suggesting that peers' influence on other children's behaviors is not affected by length of exposure, this should be tested formally by using a larger sample and evaluating the effect of peer influence among children who are new attendees of a childcare center.

Limitations of this study must be acknowledged. Aside from the potential interpretations provided, regression to the mean may also explain some of the observed changes. This is a statistical phenomenon where individuals or groups with extreme initial values are likely to have values that will be closer to the overall sample mean in the follow up score (Linden, 2013). Regression to the mean can be mitigated when multiple baseline observations are taken, as this narrows the variability around the true mean (Linden, 2013). As such, the fact that physical activity data were obtained over the course of five days, and that dietary intake data were collected over two days at both time points may have helped reduce the potential for regression to the mean. This

phenomenon still cannot be excluded as a potential explanation for our findings. In addition, two days of dietary intake measurements may not have been enough to accurately measure preschoolers' usual intake, as their appetite can fluctuate from one day to the next. Furthermore, feasibility issues prevented the assessment of snack intake which could have influenced children's food intake at lunch. Participants in our study were also of similar age, which did not allow us to assess whether children would be influenced differently by older or younger peers. It is also possible that the arrival or departure of children and educators during the course of the year could have had an impact on children's behaviors. However, all children within the childcare center would have been exposed to the same risk, thus reducing the impact that this could have had on our findings. Despite these limitations, strengths of this study include the objective measurement of children's dietary intake and physical activity, the use of a large sample derived from a population-based study and the variability in geographical location, as well as the longitudinal nature of the analyses. Also, while previous studies have used arbitrary cut points for determining valid accelerometer wear time in childcare centers, those used in our study were calculated based on non-discretionary statistical methods.

Conclusions

This study objectively assessed how peers' behaviors predicted change in preschoolers' dietary intake and physical activity over time. Specifically, our study suggests that the greater the deviation between children's dietary intake or physical activity level and those of their peers at the beginning of the year, the greater their change in dietary intake or physical activity will be over time. Our findings suggest that improving some children's eating behaviors and physical activity could indirectly result in improving other children's behaviors in childcare centers. Hence, future studies should consider the role that peers could play in promoting healthy eating behaviors and physical activity of preschoolers in this setting.

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REFERENCES

American Academy of Pediatrics, 2009. Caring for your baby and young child: Birth to age 5, 5th ed. ed. Bantam, New York, NY.

Ball, S., Bejamin, S., Ward, D., 2008. Dietary intakes in North Carolina child-care centers: are children meeting current recommendations? J Am Diet Assoc 105, 718–721.

Ball, S.C., Benjamin, S.E., Ward, D.S., 2007. Development and Reliability of an Observation Method to Assess Food Intake of Young Children in Child Care. J. Am. Diet. Assoc. 107, 656–661. doi:10.1016/j.jada.2007.01.003

Bandura, A., 1977. Social learning theory. Prentice Hall, Englewood Cliffs, NJ.

Barkley, J., Salvy, S., Sanders, G., Dey, S., Von Carlowitz, K., Williamson, M., 2014. Peer influence and physical activity behavior in young children: an experimental study. J. Phys. Act. Health 11, 404–409.

Bélanger, M., Boudreau, J., 2015. SAS Code for Actical Data Cleaning and Management [WWW Document]. Cent. Form. médicale du Nouv. URL http://www.mathieubelanger.recherche.usherbrooke.ca/Actical.fr.htm (accessed 10.20.15).

Bélanger, M., Humbert, L., Vatanparast, H., Ward, S., Muhajarine, N., Froehlich Chow, A., Engler-Stringer, E., Donovan, D., Carrier, N., Leis, A., 2016. A multilevel intervention to increase physical activity and improve healthy eating and physical literacy among young children (ages 3-5) attending early childcare centres: the Healthy Start-Départ Santé cluster randomised controlled trial study protocol. BMC Public Health 16, 313:322.

Bélanger, M., Sabiston, C., Barnett, T., O'Loughlin, E., Ward, S., Contreras, G., O'Loughlin, J., 2015. Number of years of participation in some, but not all, types of physical activity during

adolescence predicts level of physical activity in adulthood: Results from a 13-year study. Int. J. Behav. Nutr. Phys. Act. 12, 76.

Benjamin Neelon, S., Briley, M., American Dietetic Association, 2011. Position of the American Dietetic Association: benchmarks for nutrition in child care. J. Am. Diet. Assoc. 111, 607–615.

Beydoun, M., Wang, Y., 2009. Parent-child dietary intake resemblance in the United States: Evidence from a large representative survey. Soc Sci Med 68, 2137–2144.

Canadian Fitness & Lifestyle Research Institute, 2011a. Physical activity levels of Canadian children and youth in New Brunswick.

Canadian Fitness & Lifestyle Research Institute, 2011b. Kids CAN PLAY! Physical activity levels of Canadian Children and youth in Saskatchewan [WWW Document]. URL http://www.cflri.ca/media/node/972/files/CANPLAY Bulletin 2.8 SK - EN.pdf (accessed 2.26.14).

Colley, R., Garriguet, D., Janssen, I., Craig, C., Clarke, J., Tremblay, M., 2011. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. Heal. Reports 22, 15–23.

Copeland, K. a, Benjamin Neelon, S.E., Howald, A.E., Wosje, K.S., 2013. Nutritional quality of meals compared to snacks in child care. Child. Obes. 9, 223–32. doi:10.1089/chi.2012.0138

Coppinger, T., Jeanes, Y.M., Dabinett, J., Vögele, C., Reeves, S., 2010. Physical activity and dietary intake of children aged 9-11 years and the influence of peers on these behaviours: a 1-year follow-up. Eur. J. Clin. Nutr. 64, 776–781. doi:10.1038/ejcn.2010.63

Dubois, L., Farmer, A., Girard, M., Peterson, K., Tatone-Tokuda, F., 2007. Problem eating behaviors related to social factors and body weight in preschool children: A longitudinal study. Int. J. Behav. Nutr. Phys. Act. 4, 9–18. doi:http://doi.org/10.1186/1479-5868-4-9

Eaton, W., Keats, J., 1981. Peer presence and sex differences in motor activity level.

Erinosho, T.O., Ball, S.C., Hanson, P.P., Vaughn, A.E., Ward, D.S., 2013. Assessing Foods Offered to Children at Child-Care Centers Using the Healthy Eating Index-2005. J. Acad. Nutr. Diet. 113, 1084–1089. doi:10.1016/j.jand.2013.04.026

Garriget, D., 2007. Overview of Canadians ' Eating Habits. Ottawa,, ON.

Government of Canada's Rural Secretariat, 2006. Community Information Database - Metropolitan Influence Zone (MIZ) Topology [WWW Document].

Gubbels, J.., Raaijmakers, L.., Gerards, S.M., Kremers, S.P.J., 2014. Dietary intake by Dutch 1- to 3-year-old children at childcare and at home. Nutrients 6, 304–318.

Health Canada, 2012. Do Canadian children meet their nutrient requirements through food intake alone?

Health Canada, 2005. ARCHIVED - View Maps for Each Health Indicator [WWW Document]. URL http://www.hc-sc.gc.ca/fn-an/surveill/atlas/map-carte/index-eng.php#nu (accessed 2.26.14).

Jacko, C., Dellava, J., Ensle, K., Hoffman, D., 2007. Use of the plate-waste method to measure food intake in children. J. Ext. 45, 6RIB7.

Katapally, T., Muhajarine, N., 2014. Towards uniform accelerometry analysis: A standardization methodology to minimize measurement bias due to systematic accelerometer wear-time variation. J. Sport. Sci. Med. 13, 379–386.

Kirks, B., Wolff, H., 1985. A comparison of methods for plate waste determinations. J. Am. Diet. Assoc. 85, 328–331.

Kuzik, N., Clark, D., Ogden, N., Harber, V., Carson, V., 2015. Physical activity and sedentary behaviour of toddlers and preschoolers in child care centres in Alberta, Canada. Can. J. Public Heal. Rev. Can. Sante Publique 106, e178–83. doi:10.17269/CJPH.106.4794

Lally, P., van Jaarsveld, C., Potts, H., Wardle, J., 2010. How are habits formed: Modelling habit formation in the real world. Eur. J. Soc. Psychol. 40, 998–1009.

Lee, H., Lee, K., Shanklin, C., 2001. Elementary student's food consumption at lunch does not meet recommended dietary allowance for energy, iron, and vitamin A. J. Am. Diet. Assoc. 101, 1060–1063.

Linden, A., 2013. Assessing regression to the mean effects in health care initiatives. BMC Med. Res. Methodol. 13, 119. doi:10.1186/1471-2288-13-119

Liu, J., Jones, S., Probst, J., Merchant, A., Cavicchia, P., 2012. Diet, physical activity, and sedentary behaviors as risk factors for childhood obesity: an urban and rural comparison. Child Obes 8, 440–448.

Mikkilä, V., Rasanene, L., Raitakari, O., Pietinen, P., Vikari, J., Mikkila, V., Rasanen, L., Viikari, J., 2005. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. Br. Jounral Nutr. 93, 923–931.

Neumark-Sztainer, D., Story, M., Hannan, P., Tharp, T., Rex, J., 2003. Factors Associated With Changes in Physical Activity: A Cohort Study of Inactive Adolescent Girls. JAMA Pediatr. 157, 803–810.

Organisation for Economic Co-operation and Development, 2013. PF3.2 Enrolment in childcare and pre-schools, Social policies and data, OECD Family Database.

Pfeiffer, K., Mciver, K., Dowda, M., Almeida, M., Pate, R., 2006. Validation and calibration of the Actical accelerometer in preschool children. Med. Sci. Sports Exerc. 38, 152–157.

Rice, K., Trost, S., 2013. Physical activity levels among children attending family day care. J. Nutr. Educ. Behav.

Rich, C., Geraci, M., Griffiths, L., Sera, F., Dezateux, C., Cortina-Borja, M., 2013. Quality Control Methods in Accelerometer Data Processing: Defining Minimum Wear Time. PLoS One 8, 1–8. doi:10.1371/journal.pone.0067206

Salvy, S.J., Howard, M., Read, M., Mele, E., 2009. The presence of friends increases food intake in youth. Am. J. Clin. Nutr. 90, 282–287. doi:10.3945/ajcn.2009.27658

Sinha, M., Bleakney, A., 2014. Spotlight on Canadians : Results from the General Social Survey Receiving care at home Catalogue no. 89–652–X.

Ward, S., Bélanger, M., Donovan, D., Carrier, N., 2016. Relationship between eating behaviors and physical activity of preschoolers and their peers: a systematic review. Int. J. Behav. Nutr. Phys. Act. 13, 50. doi:10.1186/s12966-016-0374-x

Zecevic, C. a, Tremblay, L., Lovsin, T., Michel, L., 2010. Parental Influence on Young Children's Physical Activity. Int. J. Pediatr. 2010, 468526. doi:10.1155/2010/468526

FIGURE CAPTIONS

Figure 1. Reliability (%) heatmap and corresponding sample size, by minimum daily wear time and wear days based on accelerometry data collected in the fall of 2013 (1.5-column fitting, colored image)

Figure 2. Deviation between children's average intake in fruit and vegetables (Panel A) and children's average total physical activity (Panel B) in each quintile, and those of their peers at baseline (October 2013 and 2014) and endpoint (June 2014 and 2015). (1.5 column-fitting image)