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Association between childcare educators' practices and preschoolers' physical activity and dietary intake

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ABSTRACT

INTRODUCTION: Childcare educators may be role models for healthy eating and physical activity (PA) behaviors among young children. This study aimed to identify which childcare educators' practices are associated with preschoolers' dietary intake and PA levels.

METHODS: This cross-sectional analysis included 723 preschoolers from 50 randomly-selected childcare centers in two Canadian provinces. All data were collected in the fall of 2013 and 2014 and analysed in the fall of 2015. PA was assessed using Actical accelerometers during childcare hours for five consecutive days. Children's dietary intake was measured at lunch on two consecutive days using weighed plate waste and digital photography. Childcare educators' practices were assessed by direct observation over the course of two days, using the NAP SACC assessment tool. Associations between practices and preschoolers' PA and dietary intake were examined using multilevel linear regressions.

RESULTS: Overall, children ate more sugar (p=0.026) when educators modeled healthy eating, and they consumed fewer calories (p=0.026) and fibre (p=0.044) when children were educated on nutrition. Children also ate less fat (p=0.049) when educators did not use food as rewards. None of the educators' PA practices were associated with children's participation in PA.

CONCLUSIONS: Modeling healthy eating, providing nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers, highlighting the role that educators play in shaping preschoolers' eating behaviors. Although PA practices

where not associated with children's PA levels, there is a need to reduce sedentary time in childcare centers.

ARTICLE SUMMARY

Strengths and limitations of this study

- This study included a diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status, which were randomly selected across two Canadian provinces.
- Objective methods were used for assessing dietary intake and physical activity of preschoolers in childcare centers, and direct observation was used to measure childcare educator practices.
- Dietary intake was assessed at lunch on two consecutive days, which may not have been enough to represent preschoolers' usual intake.
- The presence of research assistants may have influenced childcare educators' practices and children's behaviors.

INTRODUCTION

Childhood obesity is currently a great public health challenge.[1] Primary prevention and treatment strategies for obesity in children include reducing energy and increasing physical activity (PA) levels.[2] The theory of observational learning [3] suggests that children's behaviors can be influenced by individuals who are part of their social environment. Specifically, the theory proposes that individuals' eating behaviors and PA can be shaped by observing and imitating others.[4] Over 80% of preschoolers (aged 2 to 5) living in developed countries receive formal childcare outside their home.[5] Preschoolers spend an average of approximately 30 hours a week in childcare centers.[6,7] Therefore childcare educators are potentially key actors for promoting healthy eating and PA behaviors in young children.[8]

Childcare centers may help shape children's eating behaviors and PA.[9,10] One systematic review reported that healthy eating interventions in childcare centers seem to have a positive influence on children's consumption of vegetables and fruit, and to improve their nutrition-related knowledge.[9] Another reported that limiting the number of children playing at one time, using ground markings and equipment, and focusing on goal setting or reinforcement were effective PA interventions.[10] A recent systematic review suggested that childcare educators may be positive role models for healthy eating behaviors and PA in preschoolers, but which childcare educator practices influence children's eating behaviors and PA is still unclear.[11] Therefore, to train childcare educators as effective role models, the evidence base must be improved.

In light of the existing literature and theory, we hypothesize that specific practices of childcare educators can positively influence healthy behaviors for preschoolers. This cross-sectional study aimed to identify the practices associated with preschoolers' dietary intake and PA levels.

METHODS

Study sample

Baseline data from the first and second year (2013-2014 and 2014-2015) of the Healthy Start – Départ Santé (HSDS) study were used for this cross-sectional analysis. HSDS is a cluster-randomised controlled trial conducted in the provinces of Saskatchewan and New Brunswick, Canada. It was designed to assess the effectiveness of an intervention promoting healthy eating and PA in childcare centers.[12] Childcare centers were selected from governmental registries of all licensed childcare centers in both provinces. Inclusion criteria for the HSDS study included not having received a nutrition or PA intervention in the past, offering a preschool program, offering lunch and, for practical purposes, having a minimum of 20 full-time preschoolers. Childcare centers that met eligibility criteria were stratified by geographical location (rural or urban) and by the language of their school district (Anglophone or Francophone), and were then randomly selected. All parents or guardians of participating children provided signed informed consent. The HSDS study received approval from the Centre Hospitalier de l'Université de Sherbrooke, the University of Saskatchewan and Health Canada ethics review boards.

Physical activity and sedentary behavior

PA was assessed using Actical accelerometers (Philips Respironics, Oregon).[13] Compared to other accelerometers, the Actical has higher intra- and inter-instrument reliability [14] and correlates at r=0.89 with directly measured oxygen consumption in preschoolers.[15] Children wore the accelerometer during childcare hours for five consecutive weekdays. Childcare educators were instructed the use of the accelerometers and were asked to put them on the children on arrival at the childcare center, and remove it before leaving.

Accelerometer data were recorded in 15 second epochs to measure time spent in PA and sedentary behavior according to predetermined thresholds validated in preschoolers.[15] Specifically, accelerometer counts of less than 25 counts per epoch indicate sedentary behavior, counts between 25 and 714 per epoch indicate light intensity PA time,[15] while countes of 715 counts or more per epoch indicate moderate to vigorous PA.[15] All data were used to determine the minimum number of valid days and hours to consider using a statistical method described by Rich et al.[16] Specifically, the Spearman-Brown formula and the intraclass correlation coefficient were used to calculate the reliability coefficients (*r*) of the mean daily counts/minute [16] and compare results among 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).[16] Results demonstrated that using a minimum of two hours of wear time per day on four consecutive days provided acceptable reliability coefficients (r= 0.79) while maximizing sample size, and was therefore set as the minimal wear time criteria to be included in the analyses. All children's PA data was then standardized to an eight hour period to control for within and

between participant wear-time variation.[17] Raw accelerometer data were cleaned and managed using SAS codes adapted for this study. [18]

Dietary intake

Children's intake of vegetables and fruit, fibre, sugar, fat and sodium was measured at lunch on two consecutive days with weighed plate waste and digital photography. The weighed plate waste method has been extensively used in studies conducted on school-aged children [19–21] and has been shown to be a precise measurement of dietary intake.[22,23] Foods were weighed and a picture taken before and after each serving. The difference in weight between the initial serving and the leftovers was used to calculate each child's food intake.[22,23] The pictures were used to validate the data collected from weighing, identify the type of the foods served, and estimate the quantity of each food item left on the plate. Recipes were obtained and used to assess the nutritional content of the foods served by using nutritional analysis software (Food Processor, version 10.10.00) from which estimated intakes of fruit, fibre, sugar, fat and sodium were derived.

Childcare educators' practices

Two trained research assistants observed educators' practices over the course of the two data collection days using 19 of the items of the Nutrition and Physical Activity Self Assessment of Child Care (NAP SACC). Each research assistant recorded their general observations independently and compared their observations at the end of the second day. Research assistants

showed excellent inter-rater reliability (Cohen's kappa =0.942, p<0.001). Three nutrition experts categorised the nutrition practices items (13 items) into 5: modeling (3 items, e.g. "When in classrooms during meal or snack times, teachers and staff eat and drink the same foods and beverages as children"), nutrition education (2 items, e.g. "Teachers talk with children informally about healthy eating"), satiety recognition (4 items, e.g. "When children request seconds, teachers ask them if they are still hungry before serving more food"), verbal encouragement (3 items e.g. "Teachers praise children for trying new or less preferred foods"), and the use of food as rewards (1 item e.g. "Teachers use food to calm upset children or encourage appropriate behavior").

Three experts in PA categorised the PA practices items (6 items) into two: informal promotion of PA (3 items, e.g. "Teachers incorporate PA into classroom routines and transitions"), which was defined as practices that stemmed from educators' own values or beliefs regarding PA, and formal promotion of PA (3 items, e.g. "Teachers offer portable play equipment to preschool children and toddlers during indoor free play time"), which are practices that are embedded in the childcare centers' daily routine or policies. Each item was scored on a scale ranging from 0 to 3 where 0 represented the practice less likely conducive to healthy behaviors and 3 represented the most favourable practice. The sum of the items in each of the 7 categories provided a score for that practice at the childcare center level and an overall nutrition and PA practices score was calculated.

Statistical analyses

Statistical analyses were conducted in the fall of 2015 using R, version 3.1.1. Normality tests were used to determine the distribution of each outcome variable. To transform the outcomes into approximately normal distributions, logarithmic transformations for fibre, sugar, MVPA and sedentary time were undertaken, and square root transformations were used for calories, fat, sodium, as well as fruit and vegetables (with and without potatoes). Multilevel linear regressions were used to evaluate the association between nutrition practices of educators and dietary intake of children, and the association between PA practices of educators and children's time spent in total PA, moderate to vigorous intensity PA, light intensity PA and sedentary activity. These analyses were adjusted for province (New Brunswick or Saskatchewan), rurality, number of children in the childcare center, and socioeconomic status of the region (based on total income of persons aged 15 years and older living in private households) which was obtained from data from the 2011 National Household Survey.[24] According to publicly available geospatial information from the Community Information Database, 2006, [25] childcare centers were defined as urban if they were in census metropolitan areas (CMAs), census agglomerations (CAs) or strong metropolitan influenced zone (MIZ). They were defined as rural if they had moderate, weak or no MIZ.

RESULTS

A total of 51 childcare centers were recruited in the first two years of the study. All 1208 preschoolers attending these childcare centers were eligible to participate and 730 (60.4%) were

recruited. For practical reasons, childcare educator practices were not assessed in one center. Therefore, practices from 50 centers were used for these analyses, with a total of 723 children.

The average age (standard deviation) of the 723 children eligible for these analyses was 4.0 (0.7) years and 52% were boys (Table 1). On average, the 436 children for whom dietary data were available at the time of these analyses had low fruit and vegetables (64.1g/day) and fibre (2.7g/day), and high sugar (13.7g/day) and sodium (487.4mg/day) intakes. For the total of 624 children providing valid accelerometer data, 64% of their time in childcare centers was spent in sedentary activities (306.7 min/day).

On average, childcare centers were awarded approximately half of the possible points for each of the nutrition and PA practices, although food rewards were used in only 2 of the 50 centers. The variance in scores was slightly greater for the PA practices than for the nutrition practices.

Table 1. Characteristics of study participants n= 723

	N	**%**
Sex		
Boys	378	52.3
Girls	345	47.7
BMI		
Underweight	79	12.2
Healthy weight	474	73.0
Overweight	73	11.3
Obese	23	3.5

Socioeconomic status		
Low (less than $50 000)	135	18.7
Medium ($50 000 - $79 999)	248	34.3
High ($80 000 and over)	340	47.0
School district		
Anglophone	401	55.5
Francophone	322	44.5
Rurality		
Rural	244	33.8
Urban	479	66.3
	Mean (SD)	**95% CI**
Age (years)	4.0 (0.7)	4.0, 4.1
BMI (kg/m^2)	20.2 (3.7)	20.0, 20.5
Dietary intake per lunch n=436		
Vegetables/Fruit (g)	64.1 (48.5)	59.6, 68.7
Vegetables/Fruit (g) *no potato	42.9 (38.3)	39.3, 46.5
Calories (kcal)	288.2 (125.7)	276.4, 300.0
Fibre (g)	2.7 (1.4)	2.5, 2.8
Sugar (g)	13.7 (12.0)	12.6, 14.8
Fat (g)	8.8 (4.4)	8.4, 9.2
Sodium (mg)	487.4 (292.2)	459.8, 514.9
Physical activity per day n=624		
Total PA (min)	171.9 (55.6)	167.5, 176.2
MVPA (min)	11.1 (15.8)	9.9, 12.3
LPA (min)	162.2 (53.6)	158.1, 166.4
Sedentary time (min)	306.7 (59.4)	302.0, 311.3

Childcare educator practices[1]		
Modeling (0-9 pts)	4.9 (1.4)	4.7, 5.0
Nutrition education (0-6 pts)	1.9 (1.5)	1.7, 2.0
Satiety recognition (0-12 pts)	5.1 (1.8)	4.9, 5.2
Verbal encouragement (0-9 pts)	3.2 (1.8)	3.0, 3.3
No use of food as rewards (0-3 pts)	2.8 (0.5)	2.8, 2.9
Overall nutrition practices (39 pts)	17.8 (4.0)	17.5, 18.2
Informal PA promotion (0-9 pts)	4.6 (2.6)	4.4, 4.8
Formal PA promotion (0-9 pts)	6.2 (2.1)	6.0, 6.4
Overall PA practices (0-18 pts)	10.8 (4.1)	10.5, 11.1

[1] High scores indicate healthier practices.

Modeling, nutrition education and not using food rewards were associated with the children's intake in one or more nutrients (Table 2). Modeling was positively associated with the intake of sugar, while nutrition education was negatively associated with the intake of calories and fibre. To put this in context, children under the supervision of educators who obtained 5 points for modeling consumed an average of 19g of sugar, versus an average of 33g among children supervised by educators who obtained 9 points (exp((log(Average sugar consumption +1) + (Educator score for modeling*β [Table 2])-1) = Intake in sugar). In addition, children would consume an average of 223 kcals when educators obtained 3 points for nutrition education, versus 167 kcals when educators obtained 6 points. Not using food rewards was negatively associated with intake in fat, however satiety recognition and verbal encouragement were not associated with children's intake of nutrients nor vegetables and fruit. None of the PA practices were associated with total time spent in PA, MVPA, LPA or sedentary activity (Table 3).

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Educator nutrition practices	Vegetables and fruit (g)[1]		Vegetables and fruit without potatoes (g)[1]		Calories (kcal)[1]		Fibre (g)[2]		Sugar (g)[2]		Fat (g)[1]		Sodium (mg)[1]	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Modeling	0.206	0.438	0.032	0.899	0.605	0.064	0.063	0.083	**0.132**	**0.026**	0.067	0.310	0.424	0.527
Nutrition education	-0.196	0.435	-0.119	0.623	**-0.675**	**0.026**	**-0.068**	**0.044**	-0.084	0.143	-0.095	0.123	-0.975	0.117
Satiety recognition	0.023	0.913	0.004	0.986	-0.036	0.894	0.011	0.715	0.013	0.792	-0.007	0.900	0.091	0.865
Verbal encouragement	0.244	0.229	0.020	0.918	-0.144	0.577	0.015	0.596	0.027	0.564	-0.032	0.532	-0.769	0.129
Not using food rewards	-0.023	0.977	0.596	0.437	-1.117	0.265	-0.023	0.834	-0.078	0.678	**-0.379**	**0.049**	-0.204	0.921
Overall nutrition practices	0.047	0.593	0.000	0.995	-0.061	0.579	0.003	0.816	0.011	0.606	-0.013	0.538	-0.200	0.362

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Square root-transformed variables; [2] Log-transformed variables.

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

Educator physical activity promotion practices	**Total PA (min)**		**MVPA[1] (min)**		**LPA (min)**		**Sedentary activity[1] (min)**	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Formal PA promotion	-0.382	0.846	-0.024	0.311	0.280	0.879	0.002	0.806
Informal PA promotion	-0.748	0.706	0.004	0.854	-0.524	0.777	0.003	0.665
Overall PA practices	-0.388	0.738	-0.007	0.622	-0.082	0.939	0.001	0.691

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Log-transformed variables.

DISCUSSION

Our results demonstrate that educators' modeling, nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers. However, the benefits of these practices may largely depend on what the childcare center offers. This study highlights the importance of educators, but also of childcare centers as a whole, in promoting healthy eating among preschoolers. However, our results did not suggest that educators influence PA-related behaviors of children under their care.

Educators' nutrition practices and children's dietary intake

When educators enthusiastically ate or drank the same foods and beverages as the children, and did not consume unhealthy foods or beverages in front of the children, preschoolers ate greater amounts of sugar. This is in line with a study that found that children's intake and acceptance of food increased when educators enthusiastically modeled healthy eating.[26] Our study's findings probably reflects the nutritional composition of the foods served in the childcare centers. For example, we observed that high-sugar containing foods, such as cookies, pastries and fruit juices, were commonly served, which is similar to previous studies that have reported that children attending childcare centers consume excess amounts of added sugars.[27,28] Thus, in order for modeling to be effective at promoting healthy eating, it is essential for childcare centers to offer nutritious foods.

The more nutrition education practices were demonstrated, such as planning nutrition-related activities and talking informally to children about food and healthy eating, the less children ate

calories and fibre. The type of nutritional information shared and the sources of this information are likely to be magazines, books, and the Internet as Canadians use these most frequently for nutrition information.[29] These sources often present erroneous, misleading and conflicting nutrition information. Furthermore, it has been reported that childcare educators believe they have to control what and how much children should eat in order to prevent childhood obesity.[30] If such beliefs are taught to children, preschoolers may also feel the need to restrict their own food intake. Providing evidence-based nutrition education could represent a promising avenue for healthy eating promotion among preschoolers.

In our study, not using food as rewards was negatively associated with fat intake. Previous studies have found that using a special desert as a reward [31], or combining positive reinforcement and a tangible reward (i.e. sticker),[32] were effective ways of increasing children's intake in fruit or vegetables. It is possible that food or non-food rewards act as extrinsic motivation for children to eat. If this extrinsic motivation is absent, children may be less inclined to eat, thus explaining our findings. However, studies have shown that offering a desirable food as a reward for eating another has been linked to an enhanced preference for the food used as a reward, while the preference for the distasteful food decreases.[33,34] Therefore, it has been suggested that verbal rewards should be used rather than tangible rewards.[35]

Previous studies have found that verbal encouragement[31,32] and encouraging preschoolers to eat healthy foods while allowing them to make their own food choices,[36] increased their consumption of fruit and vegetables. Although multivariate analyses showed that verbal

encouragement was positively associated with children's intake in fibre and sugar, fruit and vegetables and negatively associated with their intake in sodium, these associations were no longer statistically significant when clustering was accounted for in the multilevel models. Similarly, satiety recognition practices were negatively associated with children's intake in calories and sodium in the multivariate analyses, but were no longer statistically significant in the multilevel regression analyses.

Educators' physical activity promoting practices and children's physical activity levels

Our study found no association between educators' PA practices and children's PA level. Results from previous studies are inconsistent.[11] Although two studies found that offering portable play equipment to preschoolers increased their PA,[37,38] one found that not withholding PA as a mean of punishment was not associated with children's PA.[38] Another reported a decrease in children's PA when childcare educators were present.[39] Other variables may have a larger influence on children's choice to be physically active, such the PA levels of their peers,[40] or if they feel like being active or not on a particular day. Although our results were not statistically significant, it may be important for educators to create opportunities for children to be active, to encourage and model a physically active lifestyle, and to establish an environment that supports physical activity. A recent study found that PA opportunities accounted for only 48 minutes or 12% of the total childcare day.[41] The same study also found that while outdoor child-initiated free play was most common, outdoor teacher-led physical activities were the least frequently observed PA opportunity.[41] In line with findings of other studies, our results showed room for improvement as children spent a large amount of time in sedentary activities.[41–43]

Our finding that educators' practices were associated with children's dietary intake but not with PA could be explained by differences in the times at which those two behaviors were assessed. Nutrition practices were primarily observed during well-defined lunch periods, at which point children's dietary intake was also assessed. While the connection observed between educators' practices and children's eating was direct and immediate, PA practices were observed at various times during the two days of data collection and children's PA was assessed through the entire day. This disconnection is likely to have obscured any punctual association between educator practices and children's PA. This and the educators' infrequent use of PA practices could explain why no statistically significant relationship was found. Therefore, it may be important to enlighten childcare educators on how they can play a role in helping children become more physically active, by providing them with training in physical activity. Future research should investigate if increasing childcare educators' ability to facilitate, encourage, and model more PA results in preschoolers becoming more physically active.

Strengths and limitations

This study had several strengths including the use of objective methods for assessing dietary intake and PA, the direct observation of childcare educator practices by trained research assistants and the diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status. However, its limitations must be acknowledged. Children's dietary data was collected on only two days, which may not be enough to represent preschoolers' usual intake since it can fluctuate from day to day.[44] It is also possible that the presence of the research assistants influenced the childcare educators' practices and children's behaviors. Finally, the cross-sectional nature of the analyses limits the assessment of causal relationships.

Conclusion

In conclusion, our results provide insight on how childcare educators' practices may be associated with preschoolers' healthy behaviors, particularly those relating to dietary intake. We have shown that childcare educators who model healthy eating, provide nutrition education and avoid using food as rewards, could potentially help children eat healthier, provided that the foods served are also of high nutritional value. Our results suggest that interventions should include childcare educators as agents for the promotion of healthy eating among preschoolers. Although none of the PA practices were associated with the preschoolers' PA levels in our study, results demonstrate that children spend a large amount of time being sedentary. This supports the need for the development of effective interventions that aim to increase PA and decrease sedentary time in childcare centers.

Contributors

SW conceived the study, collected, analyzed and interpreted the data. MB conceived the study and interpreted the data. NC and DD interpreted the data. HV, NM, RES, AL and LH conceived the study. All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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Competing interests

The authors declare no competing interests.

Data sharing statement

Data from the Healthy Start study can be requested by emailing Professor Anne Leis; anne.leis@usask.ca.

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List of titles

Table 1: Characteristics of study participants

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Line number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 58, 64
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	58-76
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	89-108
Objectives	3	State specific objectives, including any prespecified hypotheses	109-111
Methods			
Study design	4	Present key elements of study design early in the paper	115-118
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	115-125
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	115-125
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	128-190
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	128-190
Bias	9	Describe any efforts to address potential sources of bias	128-190
Study size	10	Explain how the study size was arrived at	115-122, 211-214
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	136-151, 158-164, 181-190
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	193-208
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	211-204
		(b) Give reasons for non-participation at each stage	211-214
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	216-221 + Table 1
		(b) Indicate number of participants with missing data for each	206-210

		variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	216-225
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	227-238 + Table 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	240-245
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	320-327
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	240-327
Generalisability	21	Discuss the generalisability (external validity) of the study results	320-323
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	346-353

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between childcare educators' practices and preschoolers' physical activity and dietary intake

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Association between childcare educators' practices and preschoolers' physical activity and dietary intake

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ABSTRACT

INTRODUCTION: Childcare educators may be role models for healthy eating and physical activity (PA) behaviors among young children. This study aimed to identify which childcare educators' practices are associated with preschoolers' dietary intake and PA levels.

METHODS: This cross-sectional analysis included 723 preschoolers from 50 randomly-selected childcare centers in two Canadian provinces. All data were collected in the fall of 2013 and 2014 and analysed in the fall of 2015. PA was assessed using Actical accelerometers during childcare hours for five consecutive days. Children's dietary intake was measured at lunch on two consecutive days using weighed plate waste and digital photography. Childcare educators' practices were assessed by direct observation over the course of two days, using the NAP SACC assessment tool. Associations between practices and preschoolers' PA and dietary intake were examined using multilevel linear regressions.

RESULTS: Overall, children ate more sugar (p=0.026) when educators modeled healthy eating, and they consumed fewer calories (p=0.026) and fibre (p=0.044) when children were educated on nutrition. Children also ate less fat (p=0.049) when educators did not use food as rewards. None of the educators' PA practices were associated with children's participation in PA.

CONCLUSIONS: Modeling healthy eating, providing nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers, highlighting the role that educators play in shaping preschoolers' eating behaviors. Although PA practices

where not associated with children's PA levels, there is a need to reduce sedentary time in childcare centers.

ARTICLE SUMMARY

Strengths and limitations of this study

- This study included a diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status, which were randomly selected across two Canadian provinces.
- Objective methods were used for assessing dietary intake and physical activity of preschoolers in childcare centers, and direct observation was used to measure childcare educator practices.
- Dietary intake was assessed at lunch on two consecutive days, which may not have been enough to represent preschoolers' usual intake.
- The presence of research assistants may have influenced childcare educators' practices and children's behaviors.

INTRODUCTION

Childhood obesity is currently a great public health challenge.[1] Primary prevention and treatment strategies for obesity in children include reducing energy and increasing physical activity (PA) levels.[2] The theory of observational learning [3] suggests that children's behaviors can be influenced by individuals who are part of their social environment. Specifically, the theory proposes that individuals' eating behaviors and PA can be shaped by observing and imitating others.[4] Over 80% of preschoolers (aged 2 to 5) living in developed countries receive formal childcare outside their home.[5] Preschoolers spend an average of approximately 30 hours a week in childcare centers.[6,7] Therefore childcare educators are potentially key actors for promoting healthy eating and PA behaviors in young children.[8]

Childcare centers may help shape children's eating behaviors and PA.[9,10] One systematic review reported that healthy eating interventions in childcare centers seem to have a positive influence on children's consumption of vegetables and fruit, and to improve their nutrition-related knowledge.[9] Another reported that limiting the number of children playing at one time, using ground markings and equipment, and focusing on goal setting or reinforcement were effective PA interventions.[10] A recent systematic review suggested that childcare educators may be positive role models for healthy eating behaviors and PA in preschoolers, but which childcare educator practices influence children's eating behaviors and PA is still unclear.[11] Therefore, to train childcare educators as effective role models, the evidence base must be improved.

In light of the existing literature and theory, we hypothesize that specific practices of childcare educators can positively influence healthy behaviors for preschoolers. This cross-sectional study aimed to identify the practices associated with preschoolers' dietary intake and PA levels.

METHODS

Study sample

Baseline data from the first and second year (2013-2014 and 2014-2015) of the Healthy Start – Départ Santé (HSDS) study were used for this cross-sectional analysis. HSDS is a cluster-randomised controlled trial conducted in the provinces of Saskatchewan and New Brunswick, Canada. It was designed to assess the effectiveness of an intervention promoting healthy eating and PA in childcare centers.[12] Childcare centers were selected from governmental registries of all licensed childcare centers in both provinces. Inclusion criteria for the HSDS study included not having received a nutrition or PA intervention in the past, offering a preschool program, offering lunch and, for practical purposes, having a minimum of 20 full-time preschoolers. Childcare centers that met eligibility criteria were stratified by geographical location (rural or urban) and by the language of their school district (Anglophone or Francophone), and were then randomly selected. All parents or guardians of participating children provided signed informed consent. The HSDS study received approval from the Centre Hospitalier de l'Université de Sherbrooke, the University of Saskatchewan and Health Canada ethics review boards.

Physical activity and sedentary behavior

PA was assessed using Actical accelerometers (Philips Respironics, Oregon).[13] Compared to other accelerometers, the Actical has higher intra- and inter-instrument reliability [14] and correlates at r=0.89 with directly measured oxygen consumption in preschoolers.[15] Children wore the accelerometer during childcare hours for five consecutive weekdays. Childcare educators were instructed the use of the accelerometers and were asked to put them on the children on arrival at the childcare center, and remove it before leaving.

Accelerometer data were recorded in 15 second epochs to measure time spent in PA and sedentary behavior according to predetermined thresholds validated in preschoolers.[15] Specifically, accelerometer counts of less than 25 counts per epoch indicate sedentary behavior, counts between 25 and 714 per epoch indicate light intensity PA time,[15] while countes of 715 counts or more per epoch indicate moderate to vigorous PA.[15] All data were used to determine the minimum number of valid days and hours to consider using a statistical method described by Rich et al.[16] Specifically, the Spearman-Brown formula and the intraclass correlation coefficient were used to calculate the reliability coefficients (*r*) of the mean daily counts/minute [16] and compare results among 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).[16] Results demonstrated that using a minimum of two hours of wear time per day on four consecutive days provided acceptable reliability coefficients (r= 0.79) while maximizing sample size, and was therefore set as the minimal wear time criteria to be included in the analyses. All children's PA data was then standardized to an eight hour period to control for within and

between participant wear-time variation.[17] Raw accelerometer data were cleaned and managed using SAS codes adapted for this study. [18]

Dietary intake

Children's intake of vegetables and fruit, fibre, sugar, fat and sodium was measured at lunch on two consecutive days with weighed plate waste and digital photography. The weighed plate waste method has been extensively used in studies conducted on school-aged children [19–21] and has been shown to be a precise measurement of dietary intake.[22,23] Foods were weighed and a picture taken before and after each serving. The difference in weight between the initial serving and the leftovers was used to calculate each child's food intake.[22,23] The pictures were used to validate the data collected from weighing, identify the type of the foods served, and estimate the quantity of each food item left on the plate. Recipes were obtained and used to assess the nutritional content of the foods served by using nutritional analysis software (Food Processor, version 10.10.00) from which estimated intakes of fruit, fibre, sugar, fat and sodium were derived.

Childcare educators' practices

Two trained research assistants observed educators' practices over the course of the two data collection days using 19 of the items of the Nutrition and Physical Activity Self Assessment of Child Care (NAP SACC). Each research assistant recorded their general observations independently and compared their observations at the end of the second day. Research assistants

showed excellent inter-rater reliability (Cohen's kappa =0.942, p<0.001). Three nutrition experts categorised the nutrition practices items (13 items) into 5: modeling (3 items, e.g. "When in classrooms during meal or snack times, teachers and staff eat and drink the same foods and beverages as children"), nutrition education (2 items, e.g. "Teachers talk with children informally about healthy eating"), satiety recognition (4 items, e.g. "When children request seconds, teachers ask them if they are still hungry before serving more food"), verbal encouragement (3 items e.g. "Teachers praise children for trying new or less preferred foods"), and the use of food as rewards (1 item e.g. "Teachers use food to calm upset children or encourage appropriate behavior").

Three experts in PA categorised the PA practices items (6 items) into two: informal promotion of PA (3 items, e.g. "Teachers incorporate PA into classroom routines and transitions"), which was defined as practices that stemmed from educators' own values or beliefs regarding PA, and formal promotion of PA (3 items, e.g. "Teachers offer portable play equipment to preschool children and toddlers during indoor free play time"), which are practices that are embedded in the childcare centers' daily routine or policies. Each item was scored on a scale ranging from 0 to 3 where 0 represented the practice less likely conducive to healthy behaviors and 3 represented the most favourable practice. The sum of the items in each of the 7 categories provided a score for that practice at the childcare center level and an overall nutrition and PA practices score was calculated.

Statistical analyses

Statistical analyses were conducted in the fall of 2015 using R, version 3.1.1. Normality tests were used to determine the distribution of each outcome variable. To transform the outcomes into approximately normal distributions, logarithmic transformations for fibre, sugar, MVPA and sedentary time were undertaken, and square root transformations were used for calories, fat, sodium, as well as fruit and vegetables (with and without potatoes). Multilevel linear regressions were used to evaluate the association between nutrition practices of educators and dietary intake of children, and the association between PA practices of educators and children's time spent in total PA, moderate to vigorous intensity PA, light intensity PA and sedentary activity. These analyses were adjusted for province (New Brunswick or Saskatchewan), rurality, number of children in the childcare center, and socioeconomic status of the region (based on total income of persons aged 15 years and older living in private households) which was obtained from data from the 2011 National Household Survey.[24] According to publicly available geospatial information from the Community Information Database, 2006, [25] childcare centers were defined as urban if they were in census metropolitan areas (CMAs), census agglomerations (CAs) or strong metropolitan influenced zone (MIZ). They were defined as rural if they had moderate, weak or no MIZ.

RESULTS

A total of 51 childcare centers were recruited in the first two years of the study. All 1208 preschoolers attending these childcare centers were eligible to participate and 730 (60.4%) were

recruited. For practical reasons, childcare educator practices were not assessed in one center. Therefore, practices from 50 centers were used for these analyses, with a total of 723 children.

The average age (standard deviation) of the 723 children eligible for these analyses was 4.0 (0.7) years and 52% were boys (Table 1). On average, the 436 children for whom dietary data were available at the time of these analyses had low fruit and vegetables (64.1g/day) and fibre (2.7g/day), and high sugar (13.7g/day) and sodium (487.4mg/day) intakes. For the total of 624 children providing valid accelerometer data, 64% of their time in childcare centers was spent in sedentary activities (306.7 min/day).

On average, childcare centers were awarded approximately half of the possible points for each of the nutrition and PA practices, although food rewards were used in only 2 of the 50 centers. The variance in scores was slightly greater for the PA practices than for the nutrition practices.

Table 1. Characteristics of study participants n= 723

	N	**%**
Sex		
Boys	378	52.3
Girls	345	47.7
BMI		
Underweight	79	12.2
Healthy weight	474	73.0
Overweight	73	11.3
Obese	23	3.5

Socioeconomic status		
Low (less than $50 000)	135	18.7
Medium ($50 000 - $79 999)	248	34.3
High ($80 000 and over)	340	47.0
School district		
Anglophone	401	55.5
Francophone	322	44.5
Rurality		
Rural	244	33.8
Urban	479	66.3
	Mean (SD)	**95% CI**
Age (years)	4.0 (0.7)	4.0, 4.1
BMI (kg/m^2)	20.2 (3.7)	20.0, 20.5
Dietary intake per lunch n=436		
Vegetables/Fruit (g)	64.1 (48.5)	59.6, 68.7
Vegetables/Fruit (g) *no potato	42.9 (38.3)	39.3, 46.5
Calories (kcal)	288.2 (125.7)	276.4, 300.0
Fibre (g)	2.7 (1.4)	2.5, 2.8
Sugar (g)	13.7 (12.0)	12.6, 14.8
Fat (g)	8.8 (4.4)	8.4, 9.2
Sodium (mg)	487.4 (292.2)	459.8, 514.9
Physical activity per day n=624		
Total PA (min)	171.9 (55.6)	167.5, 176.2
MVPA (min)	11.1 (15.8)	9.9, 12.3
LPA (min)	162.2 (53.6)	158.1, 166.4
Sedentary time (min)	306.7 (59.4)	302.0, 311.3

Childcare educator practices[1]		
Modeling (0-9 pts)	4.9 (1.4)	4.7, 5.0
Nutrition education (0-6 pts)	1.9 (1.5)	1.7, 2.0
Satiety recognition (0-12 pts)	5.1 (1.8)	4.9, 5.2
Verbal encouragement (0-9 pts)	3.2 (1.8)	3.0, 3.3
No use of food as rewards (0-3 pts)	2.8 (0.5)	2.8, 2.9
Overall nutrition practices (39 pts)	17.8 (4.0)	17.5, 18.2
Informal PA promotion (0-9 pts)	4.6 (2.6)	4.4, 4.8
Formal PA promotion (0-9 pts)	6.2 (2.1)	6.0, 6.4
Overall PA practices (0-18 pts)	10.8 (4.1)	10.5, 11.1

[1] High scores indicate healthier practices.

Modeling, nutrition education and not using food rewards were associated with the children's intake in one or more nutrients (Table 2). Modeling was positively associated with the intake of sugar, while nutrition education was negatively associated with the intake of calories and fibre. To put this in context, children under the supervision of educators who obtained 5 points for modeling consumed an average of 19g of sugar, versus an average of 33g among children supervised by educators who obtained 9 points (exp((log(Average sugar consumption +1) + (Educator score for modeling*β [Table 2])-1) = Intake in sugar). In addition, children would consume an average of 223 kcals when educators obtained 3 points for nutrition education, versus 167 kcals when educators obtained 6 points. Not using food rewards was negatively associated with intake in fat, however satiety recognition and verbal encouragement were not associated with children's intake of nutrients nor vegetables and fruit. None of the PA practices were associated with total time spent in PA, MVPA, LPA or sedentary activity (Table 3).

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Educator nutrition practices	Vegetables and fruit (g)[1]		Vegetables and fruit without potatoes (g)[1]		Calories (kcal)[1]		Fibre (g)[2]		Sugar (g)[2]		Fat (g)[1]		Sodium (mg)[1]	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Modeling	0.206	0.438	0.032	0.899	0.605	0.064	0.063	0.083	**0.132**	**0.026**	0.067	0.310	0.424	0.527
Nutrition education	-0.196	0.435	-0.119	0.623	**-0.675**	**0.026**	**-0.068**	**0.044**	-0.084	0.143	-0.095	0.123	-0.975	0.117
Satiety recognition	0.023	0.913	0.004	0.986	-0.036	0.894	0.011	0.715	0.013	0.792	-0.007	0.900	0.091	0.865
Verbal encouragement	0.244	0.229	0.020	0.918	-0.144	0.577	0.015	0.596	0.027	0.564	-0.032	0.532	-0.769	0.129
Not using food rewards	-0.023	0.977	0.596	0.437	-1.117	0.265	-0.023	0.834	-0.078	0.678	**-0.379**	**0.049**	-0.204	0.921
Overall nutrition practices	0.047	0.593	0.000	0.995	-0.061	0.579	0.003	0.816	0.011	0.606	-0.013	0.538	-0.200	0.362

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Square root-transformed variables; [2] Log-transformed variables.

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

Educator physical activity promotion practices	**Total PA (min)**		**MVPA[1] (min)**		**LPA (min)**		**Sedentary activity[1] (min)**	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Formal PA promotion	-0.382	0.846	-0.024	0.311	0.280	0.879	0.002	0.806
Informal PA promotion	-0.748	0.706	0.004	0.854	-0.524	0.777	0.003	0.665
Overall PA practices	-0.388	0.738	-0.007	0.622	-0.082	0.939	0.001	0.691

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Log-transformed variables.

DISCUSSION

Our results demonstrate that educators' modeling, nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers. However, the benefits of these practices may largely depend on what the childcare center offers. This study highlights the importance of educators, but also of childcare centers as a whole, in promoting healthy eating among preschoolers. However, our results did not suggest that educators influence PA-related behaviors of children under their care.

Educators' nutrition practices and children's dietary intake

When educators enthusiastically ate or drank the same foods and beverages as the children, and did not consume unhealthy foods or beverages in front of the children, preschoolers ate greater amounts of sugar. This is in line with a study that found that children's intake and acceptance of food increased when educators enthusiastically modeled healthy eating.[26] Our study's findings probably reflects the nutritional composition of the foods served in the childcare centers. For example, we observed that high-sugar containing foods, such as cookies, pastries and fruit juices, were commonly served, which is similar to previous studies that have reported that children attending childcare centers consume excess amounts of added sugars.[27,28] Thus, in order for modeling to be effective at promoting healthy eating, it is essential for childcare centers to offer nutritious foods.

The more nutrition education practices were demonstrated, such as planning nutrition-related activities and talking informally to children about food and healthy eating, the less children ate

calories and fibre. The type of nutritional information shared and the sources of this information are likely to be magazines, books, and the Internet as Canadians use these most frequently for nutrition information.[29] These sources often present erroneous, misleading and conflicting nutrition information. Furthermore, it has been reported that childcare educators believe they have to control what and how much children should eat in order to prevent childhood obesity.[30] If such beliefs are taught to children, preschoolers may also feel the need to restrict their own food intake. Providing evidence-based nutrition education could represent a promising avenue for healthy eating promotion among preschoolers.

In our study, not using food as rewards was negatively associated with fat intake. Previous studies have found that using a special desert as a reward [31], or combining positive reinforcement and a tangible reward (i.e. sticker),[32] were effective ways of increasing children's intake in fruit or vegetables. It is possible that food or non-food rewards act as extrinsic motivation for children to eat. If this extrinsic motivation is absent, children may be less inclined to eat, thus explaining our findings. However, studies have shown that offering a desirable food as a reward for eating another has been linked to an enhanced preference for the food used as a reward, while the preference for the distasteful food decreases.[33,34] Therefore, it has been suggested that verbal rewards should be used rather than tangible rewards.[35]

Previous studies have found that verbal encouragement[31,32] and encouraging preschoolers to eat healthy foods while allowing them to make their own food choices,[36] increased their consumption of fruit and vegetables. Although multivariate analyses showed that verbal

encouragement was positively associated with children's intake in fibre and sugar, fruit and vegetables and negatively associated with their intake in sodium, these associations were no longer statistically significant when clustering was accounted for in the multilevel models. Similarly, satiety recognition practices were negatively associated with children's intake in calories and sodium in the multivariate analyses, but were no longer statistically significant in the multilevel regression analyses.

Educators' physical activity promoting practices and children's physical activity levels

Our study found no association between educators' PA practices and children's PA level. Results from previous studies are inconsistent.[11] Although two studies found that offering portable play equipment to preschoolers increased their PA,[37,38] one found that not withholding PA as a mean of punishment was not associated with children's PA.[38] Another reported a decrease in children's PA when childcare educators were present.[39] Other variables may have a larger influence on children's choice to be physically active, such the PA levels of their peers,[40] or if they feel like being active or not on a particular day. Although our results were not statistically significant, it may be important for educators to create opportunities for children to be active, to encourage and model a physically active lifestyle, and to establish an environment that supports physical activity. A recent study found that PA opportunities accounted for only 48 minutes or 12% of the total childcare day.[41] The same study also found that while outdoor child-initiated free play was most common, outdoor teacher-led physical activities were the least frequently observed PA opportunity.[41] In line with findings of other studies, our results showed room for improvement as children spent a large amount of time in sedentary activities.[41–43]

Our finding that educators' practices were associated with children's dietary intake but not with PA could be explained by differences in the times at which those two behaviors were assessed. Nutrition practices were primarily observed during well-defined lunch periods, at which point children's dietary intake was also assessed. While the connection observed between educators' practices and children's eating was direct and immediate, PA practices were observed at various times during the two days of data collection and children's PA was assessed through the entire day. This disconnection is likely to have obscured any punctual association between educator practices and children's PA. This and the educators' infrequent use of PA practices could explain why no statistically significant relationship was found. Therefore, it may be important to enlighten childcare educators on how they can play a role in helping children become more physically active, by providing them with training in physical activity. Future research should investigate if increasing childcare educators' ability to facilitate, encourage, and model more PA results in preschoolers becoming more physically active.

Strengths and limitations

This study had several strengths including the use of objective methods for assessing dietary intake and PA, the direct observation of childcare educator practices by trained research assistants and the diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status. However, its limitations must be acknowledged. Children's dietary data was collected on only two days, which may not be enough to represent preschoolers' usual intake since it can fluctuate from day to day.[44] It is also possible that the presence of the research assistants influenced the childcare educators' practices and children's behaviors. Finally, the cross-sectional nature of the analyses limits the assessment of causal relationships.

Conclusion

In conclusion, our results provide insight on how childcare educators' practices may be associated with preschoolers' healthy behaviors, particularly those relating to dietary intake. We have shown that childcare educators who model healthy eating, provide nutrition education and avoid using food as rewards, could potentially help children eat healthier, provided that the foods served are also of high nutritional value. Our results suggest that interventions should include childcare educators as agents for the promotion of healthy eating among preschoolers. Although none of the PA practices were associated with the preschoolers' PA levels in our study, results demonstrate that children spend a large amount of time being sedentary. This supports the need for the development of effective interventions that aim to increase PA and decrease sedentary time in childcare centers.

Contributors

SW conceived the study, collected, analyzed and interpreted the data. MB conceived the study and interpreted the data. NC and DD interpreted the data. HV, NM, RES, AL and LH conceived the study. All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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Competing interests

The authors declare no competing interests.

Data sharing statement

Data from the Healthy Start study can be requested by emailing Professor Anne Leis; anne.leis@usask.ca.

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List of titles

Table 1: Characteristics of study participants

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Line number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 59, 67
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	59-75
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	95-118
Objectives	3	State specific objectives, including any prespecified hypotheses	119-121
Methods			
Study design	4	Present key elements of study design early in the paper	125-130
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	125-130
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	130-138
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	145-226
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	145-226
Bias	9	Describe any efforts to address potential sources of bias	145-226
Study size	10	Explain how the study size was arrived at	138-140
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	154-171, 174-188, 199-226
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	228-251
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	138-140, 254-257
		(b) Give reasons for non-participation at each stage	254-255, 261, 263
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	216-221 + Table 1
		(b) Indicate number of participants with missing data for each	260, 263

		variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	258-268
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	272-283 + Table 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	285-290
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	367-388
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	293-364
Generalisability	21	Discuss the generalisability (external validity) of the study results	393-364
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	407-415

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Association between childcare educators' practices and preschoolers' physical activity and dietary intake: A cross-sectional analysis

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Association between childcare educators' practices and preschoolers' physical activity and dietary intake

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ABSTRACT

INTRODUCTION: Childcare educators may be role models for healthy eating and physical activity (PA) behaviors among young children. This study aimed to identify which childcare educators' practices are associated with preschoolers' dietary intake and PA levels.

METHODS: This cross-sectional analysis included 723 preschoolers from 50 randomly-selected childcare centers in two Canadian provinces. All data were collected in the fall of 2013 and 2014 and analysed in the fall of 2015. PA was assessed using Actical accelerometers during childcare hours for five consecutive days. Children's dietary intake was measured at lunch on two consecutive days using weighed plate waste and digital photography. Childcare educators' practices were assessed by direct observation over the course of two days, using the NAP SACC assessment tool. Associations between practices and preschoolers' PA and dietary intake were examined using multilevel linear regressions.

RESULTS: Overall, children ate more sugar (p=0.026) when educators modeled healthy eating, and they consumed fewer calories (p=0.026) and fibre (p=0.044) when children were educated on nutrition. Children also ate less fat (p=0.049) when educators did not use food as rewards. None of the educators' PA practices were associated with children's participation in PA.

CONCLUSIONS: Modeling healthy eating, providing nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers, highlighting the role that educators play in shaping preschoolers' eating behaviors. Although PA practices

where not associated with children's PA levels, there is a need to reduce sedentary time in childcare centers.

ARTICLE SUMMARY

Strengths and limitations of this study

- This study included a diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status, which were randomly selected across two Canadian provinces.
- Objective methods were used for assessing dietary intake and physical activity of preschoolers in childcare centers, and direct observation was used to measure childcare educator practices.
- Dietary intake was assessed at lunch on two consecutive days, which may not have been enough to represent preschoolers' usual intake.
- The presence of research assistants may have influenced childcare educators' practices and children's behaviors.

INTRODUCTION

Childhood obesity is currently a great public health challenge.[1] Primary prevention and treatment strategies for obesity in children include reducing energy and increasing physical activity (PA) levels.[2] The theory of observational learning [3] suggests that children's behaviors can be influenced by individuals who are part of their social environment. Specifically, the theory proposes that individuals' eating behaviors and PA can be shaped by observing and imitating others.[4] Over 80% of preschoolers (aged 2 to 5) living in developed countries receive formal childcare outside their home.[5] Preschoolers spend an average of approximately 30 hours a week in childcare centers.[6,7] Therefore childcare educators are potentially key actors for promoting healthy eating and PA behaviors in young children.[8]

Childcare centers may help shape children's eating behaviors and PA.[9,10] One systematic review reported that healthy eating interventions in childcare centers seem to have a positive influence on children's consumption of vegetables and fruit, and to improve their nutrition-related knowledge.[9] Another reported that limiting the number of children playing at one time, using ground markings and equipment, and focusing on goal setting or reinforcement were effective PA interventions.[10] A recent systematic review suggested that childcare educators may be positive role models for healthy eating behaviors and PA in preschoolers, but which childcare educator practices influence children's eating behaviors and PA is still unclear.[11] Therefore, to train childcare educators as effective role models, the evidence base must be improved.

In light of the existing literature and theory, we hypothesize that specific practices of childcare educators can positively influence healthy behaviors for preschoolers. This cross-sectional study aimed to identify the practices associated with preschoolers' dietary intake and PA levels.

METHODS

Study sample

Baseline data from the first and second year (2013-2014 and 2014-2015) of the Healthy Start – Départ Santé (HSDS) study were used for this cross-sectional analysis. HSDS is a cluster-randomised controlled trial conducted in the provinces of Saskatchewan and New Brunswick, Canada. It was designed to assess the effectiveness of an intervention promoting healthy eating and PA in childcare centers.[12] Childcare centers were selected from governmental registries of all licensed childcare centers in both provinces. Inclusion criteria for the HSDS study included not having received a nutrition or PA intervention in the past, offering a preschool program, offering lunch and, for practical purposes, having a minimum of 20 full-time preschoolers. Childcare centers that met eligibility criteria were stratified by geographical location (rural or urban) and by the language of their school district (Anglophone or Francophone), and were then randomly selected. All parents or guardians of participating children provided signed informed consent. The HSDS study received approval from the Centre Hospitalier de l'Université de Sherbrooke, the University of Saskatchewan and Health Canada ethics review boards.

Physical activity and sedentary behavior

PA was assessed using Actical accelerometers (Philips Respironics, Oregon).[13] Compared to other accelerometers, the Actical has higher intra- and inter-instrument reliability [14] and correlates at r=0.89 with directly measured oxygen consumption in preschoolers.[15] Children wore the accelerometer during childcare hours for five consecutive weekdays. Childcare educators were instructed the use of the accelerometers and were asked to put them on the children on arrival at the childcare center, and remove it before leaving.

Accelerometer data were recorded in 15 second epochs to measure time spent in PA and sedentary behavior according to predetermined thresholds validated in preschoolers.[15] Specifically, accelerometer counts of less than 25 counts per epoch indicate sedentary behavior, counts between 25 and 714 per epoch indicate light intensity PA time,[15] while countes of 715 counts or more per epoch indicate moderate to vigorous PA.[15] All data were used to determine the minimum number of valid days and hours to consider using a statistical method described by Rich et al.[16] Specifically, the Spearman-Brown formula and the intraclass correlation coefficient were used to calculate the reliability coefficients (*r*) of the mean daily counts/minute [16] and compare results among 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).[16] Results demonstrated that using a minimum of two hours of wear time per day on four consecutive days provided acceptable reliability coefficients (r= 0.79) while maximizing sample size, and was therefore set as the minimal wear time criteria to be included in the analyses. All children's PA data was then standardized to an eight hour period to control for within and

between participant wear-time variation.[17] Raw accelerometer data were cleaned and managed using SAS codes adapted for this study. [18]

Dietary intake

Children's intake of vegetables and fruit, fibre, sugar, fat and sodium was measured at lunch on two consecutive days with weighed plate waste and digital photography. The weighed plate waste method has been extensively used in studies conducted on school-aged children [19–21] and has been shown to be a precise measurement of dietary intake.[22,23] Foods were weighed and a picture taken before and after each serving. The difference in weight between the initial serving and the leftovers was used to calculate each child's food intake.[22,23] The pictures were used to validate the data collected from weighing, identify the type of the foods served, and estimate the quantity of each food item left on the plate. Recipes were obtained and used to assess the nutritional content of the foods served by using nutritional analysis software (Food Processor, version 10.10.00) from which estimated intakes of fruit, fibre, sugar, fat and sodium were derived.

Childcare educators' practices

Two trained research assistants observed educators' practices over the course of the two data collection days using 19 of the items of the Nutrition and Physical Activity Self Assessment of Child Care (NAP SACC). Each research assistant recorded their general observations independently and compared their observations at the end of the second day. Research assistants

showed excellent inter-rater reliability (Cohen's kappa =0.942, p<0.001). Three nutrition experts categorised the nutrition practices items (13 items) into 5: modeling (3 items, e.g. "When in classrooms during meal or snack times, teachers and staff eat and drink the same foods and beverages as children"), nutrition education (2 items, e.g. "Teachers talk with children informally about healthy eating"), satiety recognition (4 items, e.g. "When children request seconds, teachers ask them if they are still hungry before serving more food"), verbal encouragement (3 items e.g. "Teachers praise children for trying new or less preferred foods"), and the use of food as rewards (1 item e.g. "Teachers use food to calm upset children or encourage appropriate behavior").

Three experts in PA categorised the PA practices items (6 items) into two: informal promotion of PA (3 items, e.g. "Teachers incorporate PA into classroom routines and transitions"), which was defined as practices that stemmed from educators' own values or beliefs regarding PA, and formal promotion of PA (3 items, e.g. "Teachers offer portable play equipment to preschool children and toddlers during indoor free play time"), which are practices that are embedded in the childcare centers' daily routine or policies. Each item was scored on a scale ranging from 0 to 3 where 0 represented the practice less likely conducive to healthy behaviors and 3 represented the most favourable practice. The sum of the items in each of the 7 categories provided a score for that practice at the childcare center level and an overall nutrition and PA practices score was calculated.

Statistical analyses

Statistical analyses were conducted in the fall of 2015 using R, version 3.1.1. Normality tests were used to determine the distribution of each outcome variable. To transform the outcomes into approximately normal distributions, logarithmic transformations for fibre, sugar, MVPA and sedentary time were undertaken, and square root transformations were used for calories, fat, sodium, as well as fruit and vegetables (with and without potatoes). Multilevel linear regressions were used to evaluate the association between nutrition practices of educators and dietary intake of children, and the association between PA practices of educators and children's time spent in total PA, moderate to vigorous intensity PA, light intensity PA and sedentary activity. These analyses were adjusted for province (New Brunswick or Saskatchewan), rurality, number of children in the childcare center, and socioeconomic status of the region (based on total income of persons aged 15 years and older living in private households) which was obtained from data from the 2011 National Household Survey.[24] According to publicly available geospatial information from the Community Information Database, 2006, [25] childcare centers were defined as urban if they were in census metropolitan areas (CMAs), census agglomerations (CAs) or strong metropolitan influenced zone (MIZ). They were defined as rural if they had moderate, weak or no MIZ.

RESULTS

A total of 51 childcare centers were recruited in the first two years of the study. All 1208 preschoolers attending these childcare centers were eligible to participate and 730 (60.4%) were

recruited. For practical reasons, childcare educator practices were not assessed in one center. Therefore, practices from 50 centers were used for these analyses, with a total of 723 children.

The average age (standard deviation) of the 723 children eligible for these analyses was 4.0 (0.7) years and 52% were boys (Table 1). On average, the 436 children for whom dietary data were available at the time of these analyses had low fruit and vegetables (64.1g/day) and fibre (2.7g/day), and high sugar (13.7g/day) and sodium (487.4mg/day) intakes. For the total of 624 children providing valid accelerometer data, 64% of their time in childcare centers was spent in sedentary activities (306.7 min/day).

On average, childcare centers were awarded approximately half of the possible points for each of the nutrition and PA practices, although food rewards were used in only 2 of the 50 centers. The variance in scores was slightly greater for the PA practices than for the nutrition practices.

Table 1. Characteristics of study participants n= 723

	N	**%**
Sex		
Boys	378	52.3
Girls	345	47.7
BMI		
Underweight	79	12.2
Healthy weight	474	73.0
Overweight	73	11.3
Obese	23	3.5

Socioeconomic status		
Low (less than $50 000)	135	18.7
Medium ($50 000 - $79 999)	248	34.3
High ($80 000 and over)	340	47.0
School district		
Anglophone	401	55.5
Francophone	322	44.5
Rurality		
Rural	244	33.8
Urban	479	66.3
	Mean (SD)	**95% CI**
Age (years)	4.0 (0.7)	4.0, 4.1
BMI (kg/m^2)	20.2 (3.7)	20.0, 20.5
Dietary intake per lunch n=436		
Vegetables/Fruit (g)	64.1 (48.5)	59.6, 68.7
Vegetables/Fruit (g) *no potato	42.9 (38.3)	39.3, 46.5
Calories (kcal)	288.2 (125.7)	276.4, 300.0
Fibre (g)	2.7 (1.4)	2.5, 2.8
Sugar (g)	13.7 (12.0)	12.6, 14.8
Fat (g)	8.8 (4.4)	8.4, 9.2
Sodium (mg)	487.4 (292.2)	459.8, 514.9
Physical activity per day n=624		
Total PA (min)	171.9 (55.6)	167.5, 176.2
MVPA (min)	11.1 (15.8)	9.9, 12.3
LPA (min)	162.2 (53.6)	158.1, 166.4
Sedentary time (min)	306.7 (59.4)	302.0, 311.3

Childcare educator practices[1]		
Modeling (0-9 pts)	4.9 (1.4)	4.7, 5.0
Nutrition education (0-6 pts)	1.9 (1.5)	1.7, 2.0
Satiety recognition (0-12 pts)	5.1 (1.8)	4.9, 5.2
Verbal encouragement (0-9 pts)	3.2 (1.8)	3.0, 3.3
No use of food as rewards (0-3 pts)	2.8 (0.5)	2.8, 2.9
Overall nutrition practices (39 pts)	17.8 (4.0)	17.5, 18.2
Informal PA promotion (0-9 pts)	4.6 (2.6)	4.4, 4.8
Formal PA promotion (0-9 pts)	6.2 (2.1)	6.0, 6.4
Overall PA practices (0-18 pts)	10.8 (4.1)	10.5, 11.1

[1] High scores indicate healthier practices.

Modeling, nutrition education and not using food rewards were associated with the children's intake in one or more nutrients (Table 2). Modeling was positively associated with the intake of sugar, while nutrition education was negatively associated with the intake of calories and fibre. To put this in context, children under the supervision of educators who obtained 5 points for modeling consumed an average of 19g of sugar, versus an average of 33g among children supervised by educators who obtained 9 points (exp((log(Average sugar consumption +1) + (Educator score for modeling*β [Table 2])-1) = Intake in sugar). In addition, children would consume an average of 223 kcals when educators obtained 3 points for nutrition education, versus 167 kcals when educators obtained 6 points. Not using food rewards was negatively associated with intake in fat, however satiety recognition and verbal encouragement were not associated with children's intake of nutrients nor vegetables and fruit. None of the PA practices were associated with total time spent in PA, MVPA, LPA or sedentary activity (Table 3).

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Educator nutrition practices	Vegetables and fruit (g)[1]		Vegetables and fruit without potatoes (g)[1]		Calories (kcal)[1]		Fibre (g)[2]		Sugar (g)[2]		Fat (g)[1]		Sodium (mg)[1]	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Modeling	0.206	0.438	0.032	0.899	0.605	0.064	0.063	0.083	**0.132**	**0.026**	0.067	0.310	0.424	0.527
Nutrition education	-0.196	0.435	-0.119	0.623	**-0.675**	**0.026**	**-0.068**	**0.044**	-0.084	0.143	-0.095	0.123	-0.975	0.117
Satiety recognition	0.023	0.913	0.004	0.986	-0.036	0.894	0.011	0.715	0.013	0.792	-0.007	0.900	0.091	0.865
Verbal encouragement	0.244	0.229	0.020	0.918	-0.144	0.577	0.015	0.596	0.027	0.564	-0.032	0.532	-0.769	0.129
Not using food rewards	-0.023	0.977	0.596	0.437	-1.117	0.265	-0.023	0.834	-0.078	0.678	**-0.379**	**0.049**	-0.204	0.921
Overall nutrition practices	0.047	0.593	0.000	0.995	-0.061	0.579	0.003	0.816	0.011	0.606	-0.013	0.538	-0.200	0.362

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Square root-transformed variables; [2] Log-transformed variables.

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

Educator physical activity promotion practices	**Total PA (min)**		**MVPA[1] (min)**		**LPA (min)**		**Sedentary activity[1] (min)**	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
Formal PA promotion	-0.382	0.846	-0.024	0.311	0.280	0.879	0.002	0.806
Informal PA promotion	-0.748	0.706	0.004	0.854	-0.524	0.777	0.003	0.665
Overall PA practices	-0.388	0.738	-0.007	0.622	-0.082	0.939	0.001	0.691

Estimates are adjusted for province, rurality, SES and daycare size. Boldface indicates statistical significance ($p<0.05$). [1] Log-transformed variables.

DISCUSSION

Our results demonstrate that educators' modeling, nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centers. However, the benefits of these practices may largely depend on what the childcare center offers. This study highlights the importance of educators, but also of childcare centers as a whole, in promoting healthy eating among preschoolers. However, our results did not suggest that educators influence PA-related behaviors of children under their care.

Educators' nutrition practices and children's dietary intake

When educators enthusiastically ate or drank the same foods and beverages as the children, and did not consume unhealthy foods or beverages in front of the children, preschoolers ate greater amounts of sugar. This is in line with a study that found that children's intake and acceptance of food increased when educators enthusiastically modeled healthy eating.[26] Our study's findings probably reflects the nutritional composition of the foods served in the childcare centers. For example, we observed that high-sugar containing foods, such as cookies, pastries and fruit juices, were commonly served, which is similar to previous studies that have reported that children attending childcare centers consume excess amounts of added sugars.[27,28] Thus, in order for modeling to be effective at promoting healthy eating, it is essential for childcare centers to offer nutritious foods.

The more nutrition education practices were demonstrated, such as planning nutrition-related activities and talking informally to children about food and healthy eating, the less children ate

calories and fibre. The type of nutritional information shared and the sources of this information are likely to be magazines, books, and the Internet as Canadians use these most frequently for nutrition information.[29] These sources often present erroneous, misleading and conflicting nutrition information. Furthermore, it has been reported that childcare educators believe they have to control what and how much children should eat in order to prevent childhood obesity.[30] If such beliefs are taught to children, preschoolers may also feel the need to restrict their own food intake. Providing evidence-based nutrition education could represent a promising avenue for healthy eating promotion among preschoolers.

In our study, not using food as rewards was negatively associated with fat intake. Previous studies have found that using a special desert as a reward [31], or combining positive reinforcement and a tangible reward (i.e. sticker),[32] were effective ways of increasing children's intake in fruit or vegetables. It is possible that food or non-food rewards act as extrinsic motivation for children to eat. If this extrinsic motivation is absent, children may be less inclined to eat, thus explaining our findings. However, studies have shown that offering a desirable food as a reward for eating another has been linked to an enhanced preference for the food used as a reward, while the preference for the distasteful food decreases.[33,34] Therefore, it has been suggested that verbal rewards should be used rather than tangible rewards.[35]

Previous studies have found that verbal encouragement[31,32] and encouraging preschoolers to eat healthy foods while allowing them to make their own food choices,[36] increased their consumption of fruit and vegetables. Although multivariate analyses showed that verbal

encouragement was positively associated with children's intake in fibre and sugar, fruit and vegetables and negatively associated with their intake in sodium, these associations were no longer statistically significant when clustering was accounted for in the multilevel models. Similarly, satiety recognition practices were negatively associated with children's intake in calories and sodium in the multivariate analyses, but were no longer statistically significant in the multilevel regression analyses.

Educators' physical activity promoting practices and children's physical activity levels

Our study found no association between educators' PA practices and children's PA level. Results from previous studies are inconsistent.[11] Although two studies found that offering portable play equipment to preschoolers increased their PA,[37,38] one found that not withholding PA as a mean of punishment was not associated with children's PA.[38] Another reported a decrease in children's PA when childcare educators were present.[39] Other variables may have a larger influence on children's choice to be physically active, such the PA levels of their peers,[40] or if they feel like being active or not on a particular day. Although our results were not statistically significant, it may be important for educators to create opportunities for children to be active, to encourage and model a physically active lifestyle, and to establish an environment that supports physical activity. A recent study found that PA opportunities accounted for only 48 minutes or 12% of the total childcare day.[41] The same study also found that while outdoor child-initiated free play was most common, outdoor teacher-led physical activities were the least frequently observed PA opportunity.[41] In line with findings of other studies, our results showed room for improvement as children spent a large amount of time in sedentary activities.[41–43]

Our finding that educators' practices were associated with children's dietary intake but not with PA could be explained by differences in the times at which those two behaviors were assessed. Nutrition practices were primarily observed during well-defined lunch periods, at which point children's dietary intake was also assessed. While the connection observed between educators' practices and children's eating was direct and immediate, PA practices were observed at various times during the two days of data collection and children's PA was assessed through the entire day. This disconnection is likely to have obscured any punctual association between educator practices and children's PA. This and the educators' infrequent use of PA practices could explain why no statistically significant relationship was found. Therefore, it may be important to enlighten childcare educators on how they can play a role in helping children become more physically active, by providing them with training in physical activity. Future research should investigate if increasing childcare educators' ability to facilitate, encourage, and model more PA results in preschoolers becoming more physically active.

Strengths and limitations

This study had several strengths including the use of objective methods for assessing dietary intake and PA, the direct observation of childcare educator practices by trained research assistants and the diversity of childcare centers in terms of geographical location, language spoken and socioeconomic status. However, its limitations must be acknowledged. Children's dietary data was collected on only two days, which may not be enough to represent preschoolers' usual intake since it can fluctuate from day to day.[44] It is also possible that the presence of the research assistants influenced the childcare educators' practices and children's behaviors. Finally, the cross-sectional nature of the analyses limits the assessment of causal relationships.

Conclusion

In conclusion, our results provide insight on how childcare educators' practices may be associated with preschoolers' healthy behaviors, particularly those relating to dietary intake. We have shown that childcare educators who model healthy eating, provide nutrition education and avoid using food as rewards, could potentially help children eat healthier, provided that the foods served are also of high nutritional value. Our results suggest that interventions should include childcare educators as agents for the promotion of healthy eating among preschoolers. Although none of the PA practices were associated with the preschoolers' PA levels in our study, results demonstrate that children spend a large amount of time being sedentary. This supports the need for the development of effective interventions that aim to increase PA and decrease sedentary time in childcare centers.

Contributors

SW conceived the study, collected, analyzed and interpreted the data. MB conceived the study and interpreted the data. NC and DD interpreted the data. HV, NM, RES, AL and LH conceived the study. All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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Competing interests

The authors declare no competing interests.

Data sharing statement

Data from the Healthy Start study can be requested by emailing Professor Anne Leis; anne.leis@usask.ca.

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List of titles

Table 1: Characteristics of study participants

Table 2. Multilevel linear regression derived estimates of the association between educators' practices and children's dietary intake

Table 3. Multilevel linear regression derived estimates of the association between educators' practices and children's physical activity

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Line number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1, 59, 67
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	59-75
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	95-118
Objectives	3	State specific objectives, including any prespecified hypotheses	119-121
Methods			
Study design	4	Present key elements of study design early in the paper	125-130
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	125-130
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	130-138
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	145-226
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	145-226
Bias	9	Describe any efforts to address potential sources of bias	145-226
Study size	10	Explain how the study size was arrived at	138-140
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	154-171, 174-188, 199-226
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	228-251
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	138-140, 254-257
		(b) Give reasons for non-participation at each stage	254-255, 261, 263
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	216-221 + Table 1
		(b) Indicate number of participants with missing data for each	260, 263

		variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	258-268
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	272-283 + Table 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	285-290
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	367-388
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	293-364
Generalisability	21	Discuss the generalisability (external validity) of the study results	393-364
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	407-415

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.