

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

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ABSTRACT

Introduction Childcare educators may be role models for healthy eating and physical activity (PA) behaviours 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 centres 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 5 consecutive days. Children's dietary intake was measured at lunch on 2 consecutive days using weighed plate waste and digital photography. Childcare educators' nutrition practices (modelling, nutrition education, satiety recognition, verbal encouragement and not using food as rewards) and PA practices (informal and formal PA promotion) were assessed by direct observation over the course of 2 days, using the Nutrition and Physical Activity Self-Assessment for Child Care tool. Associations between educators' practices and preschoolers' PA and dietary intake were examined using multilevel linear regressions.

Results Overall, modelling of healthy eating was positively associated with children's intake of sugar ($\beta=0.141$, 95% CI 0.03 to 0.27), while calorie ($\beta=-0.456$, 95% CI -1.46 to -0.02) and fibre intake ($\beta=-0.066$, 95% CI -0.12 to -0.01) were negatively associated with providing nutrition education. Not using food as rewards was also negatively associated with fat intake ($\beta=-0.144$, 95% CI -0.52 to -0.002). None of the educators' PA practices were associated with children's participation in PA.

Conclusions Modelling healthy eating, providing nutrition education and not using food as rewards are associated with children's dietary intake at lunch in childcare centres, highlighting the role that educators play in shaping preschoolers' eating behaviours. Although PA practices were not associated with children's PA levels, there is a need to reduce sedentary time in childcare centres.

INTRODUCTION

Childhood obesity is currently a great public health challenge.¹ Primary prevention and treatment strategies for obesity in

Strengths and limitations of this study

- This study included a diversity of childcare centres 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 centres, and direct observation was used to measure childcare educators' practices.
- Dietary intake was assessed at lunch on 2 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 behaviours.

children include reducing energy intake and increasing physical activity (PA) levels.² The theory of observational learning³ suggests that children's behaviours can be influenced by individuals who are part of their social environment. Specifically, the theory proposes that individuals' eating behaviours and PA can be shaped by observing and imitating others.⁴ Over 80% of preschoolers (aged 2–5) living in developed countries receive formal childcare outside their home.⁵ Preschoolers spend an average of approximately 30 hours a week in childcare centres.^{6,7} Therefore, childcare educators are potentially key actors for promoting healthy eating and PA behaviours in young children.⁸

Childcare centres may help shape children's eating behaviours and PA.^{9,10} One systematic review reported that healthy eating interventions in childcare centres 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



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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 behaviours and PA in preschoolers, but which childcare educators' practices influence children's eating behaviours and PA is still unclear.¹¹ For example, while studies have found that some educator practices and behaviours promote or are positively associated with PA (eg, leading PA activities, participating in children's PA)^{12–16} and healthy eating (eg, eating with the children, talking about healthy foods),^{17–19} the same practices, in addition to others, were also found to be non-significant in other studies.^{14 17 18 20} Therefore, to train childcare educators as effective role models, the evidence base must be improved.

In light of the existing literature and theory, we hypothesise that specific practices of childcare educators can positively influence healthy behaviours for preschoolers. This cross-sectional study aimed to identify practices that are 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 secondary analysis. HSDS is a cluster-randomised controlled trial (#NCT02375490) 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 centres.²¹ Details of the HSDS study have been published elsewhere²¹ and are presented briefly herein. Childcare centres were selected from governmental registries of all licensed childcare centres in both provinces. Inclusion criteria for the HSDS study included not having received a nutrition or PA intervention in the past, offering a preschool programme, offering lunch and, for practical purposes, having a minimum of 20 full-time preschoolers. Childcare centres 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. In the first 2 years of the HSDS study, a total of 84 childcare centres were contacted by telephone, provided with information and invited to participate. Consent was obtained from 51 of those centres (61%). All 1208 preschoolers attending these childcare centres on a full-time basis were eligible to participate and parents of 730 children (60.4%) provided signed, informed consent. All parents or guardians of participating children provided signed informed consent.

PA and sedentary behaviour

PA was assessed using Actical accelerometers (B and Z-series, Mini Mitter/Respironics, Oregon, USA).²² Compared

with other accelerometers, the Actical has higher intra-instrument and inter-instrument reliability²³ and correlates at $r=0.89$ with directly measured oxygen consumption in preschoolers.²⁴ Accelerometers were programmed by research assistants the night before they were provided to the children. Monitoring start date and time were entered as midnight of the following day. Children wore the accelerometer on their hip during childcare hours for 5 consecutive weekdays in the fall of 2013 and 2014. Childcare educators were instructed the use of the accelerometers and were asked to put them on the children on arrival at the childcare centre and remove them before leaving. Since the accelerometers are digitally time stamped, educators were not required to log when accelerometers were put on or taken off.

Accelerometer data were recorded in 15s epochs to measure time spent in PA and sedentary behaviour according to predetermined thresholds validated in preschoolers.²⁴ Specifically, accelerometer counts of less than 25 counts per epoch indicate sedentary behaviour (which includes nap time),²⁵ counts between 25 and 714 per epoch indicate light intensity PA (LPA) time,^{24 25} while counts of 715 counts or more per epoch indicate moderate to vigorous intensity PA (MVPA).²⁴ Data obtained in the first year of the study were used to determine the minimum number of valid days and hours to consider using a statistical method described by Rich *et al.*²⁶ Specifically, the Spearman-Brown formula and the intraclass correlation coefficient were used to calculate the reliability coefficients (r) of the mean daily counts/minute²⁶ and compare results among children who met wear times between 1 and 10 hours (based on typical childcare hours of 7:30–17:30) and wear days between 1 and 5 (Monday–Friday).²⁶ The results demonstrated that using a minimum of 2 hours of wear time per day on 4 consecutive days provided acceptable reliability coefficients ($r=0.79$) while maximising sample size ($n=360$) and was therefore set as the minimal wear time criterion to be included in the analyses.²⁷ This is similar to previous studies in childcare centres which have used a minimum of 1 hour of wear time per day on at least 3 days.^{28–30} All children's PA data were then standardised to an 8-hour period to control for within-participant and between-participant wear-time variations.³¹ Raw accelerometer data were cleaned and managed using SAS codes adapted for this study.³²

Dietary intake

Children's intake of vegetables and fruit, fibre, sugar, fat and sodium was measured at lunch on 2 consecutive days with weighed plate waste and digital photography. The weighed plate waste method has been extensively used in studies conducted in school-aged children^{33–35} and has been shown to be a precise measurement of dietary intake.^{36 37} 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.^{36 37} If food was spilled or dropped

around the child's plate or chair, it was gathered, weighed and added as leftovers. As for spilled beverages, research assistants visually assessed the amount spilled compared with the amount served to estimate the amount consumed by the child. No trades were observed as all children were served the same foods. Pictures were used to validate the data collected from weighing, identify the types of 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, V.10.10.00) from which estimated intakes of vegetables and fruit, fibre, sugar, fat and sodium were derived. Children's average dietary intake over the 2 days of data collection was then calculated.

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 for Child Care (NAP SACC).^{38 39} These items were selected as they specifically assessed educators' practices. 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 five types of practices: modelling (three items, ie, 'When in classrooms during meal or snack times, teachers and staff eat and drink the same foods and beverages as children'; 'Teachers enthusiastically role model eating healthy foods served at meal and snack times'; 'Teachers and staff eat or drink unhealthy foods or beverages in front of children'), nutrition education (two items, ie, 'Teachers talk with children informally about healthy eating'; 'Teachers incorporate planned nutrition education into their classroom routines'), satiety recognition (four items, ie, 'Meals and snacks are served to preschool children by...'; 'When children eat less than half of a meal or snack, teachers ask them if they are full before removing their plates'; 'When children request seconds, teachers ask them if they are still hungry before serving more food'; 'Teachers require that children sit at the table until they clean their plates'), verbal encouragement (three items, ie, 'During indoor and outdoor physically active playtime, teachers remind children to drink water...'; 'Teachers praise children for trying new or less preferred foods'; 'Teachers use an authoritative feeding style') and the use of food as rewards (one item, ie, 'Teachers use food to calm upset children or encourage appropriate behaviour').

Three experts in PA categorised the PA practices items (six items) into two types of practices: informal promotion of PA (three items, ie, 'Teachers take the following role during preschool children's physically active playtime...'; 'Teachers incorporate PA into classroom routines and transitions'; 'Teachers talk with children informally about the importance of PA'), which

was defined as practices that stemmed from educators' own values or beliefs regarding PA, and formal promotion of PA (three items, ie, 'Teachers offer portable play equipment to preschool children and toddlers during indoor free play time'; 'As punishment for misbehaviour, preschool children or toddlers are removed from physically active playtime for longer than 5 min'; 'Teachers lead planned lessons to build preschool children's and toddlers' motor skills'), which are practices that are embedded in the childcare centres' 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 behaviours and 3 represented the most favourable practice. The sum of the items in each of the seven categories provided a score for that practice at the childcare centre level and an overall nutrition and PA practices score was calculated.

Statistical analyses

Statistical analyses were conducted in the fall of 2015 using R, V.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, MVPA, LPA and sedentary activity. Models were computed in three steps. First, univariate models were generated (Step 1), followed by models which included all covariates such as province (New Brunswick or Saskatchewan), rurality, number of children in the childcare centre and socioeconomic status of the region (Step 2). Models were then fully adjusted by including childcare centres at an additional level to account for potential clustering (Step 3). Socioeconomic status of the region was 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.⁴⁰ According to publicly available geospatial information from the Community Information Database, 2006,⁴¹ childcare centres were defined as urban if they were in census metropolitan areas, census agglomerations or strong metropolitan influenced zone (MIZ). They were defined as rural if they had moderate, weak or no MIZ. Although body mass index (BMI) was not entered in the models as a confounding variable, the age-adjusted BMIs of children, based on the International Obesity Task Force criteria,⁴² are presented to give demographic context to this study's sample. Age-adjusted BMI was obtained by calculating the ratio between their weight in kilograms (measured using the Conair scale, CN2010CX model) and the square of their height in metres (measured using the SECA 213 portable stadiometer).

RESULTS

Since data collection took longer than expected in one of the 51 centres recruited, research assistants were not able to provide an accurate assessment of educators' practices in that centre. Therefore, 50 centres were retained for these analyses and a total of 723 children provided data and were included.

The average age (SD) of the 723 children was 4.0 (0.7) years and 52% were boys (table 1). On average, the 436 children who were present at lunch on at least one of the 2 days and for whom dietary data were collected and available at the time of these analyses had low fruit and vegetables (64.1 g/day) and fibre (2.7 g/day), and high sugar (13.7 g/day) and sodium (487.4 mg/day) intakes. For the total of 624 children providing valid accelerometer data, 64% of their time in childcare centres was spent in sedentary activities (306.7 min/day).

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

Modelling, nutrition education and not using food rewards were associated with the children's intake of one or more nutrients (table 2). Modelling 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 modelling consumed an average of 28 g of sugar, versus an average of 48 g among children supervised by educators who obtained 9 points. In addition, children would consume an average of 223 kcal when educators obtained 3 points for nutrition education, versus 167 kcal when educators obtained 6 points. Not using food rewards was negatively associated with intake of 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).

DISCUSSION

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

Table 1 Characteristics of study participants

	n (%) Mean±SD; 95% CI
Child-level characteristics n=723	
Sex	
Boys	378 (52.3)
Girls	345 (47.7)
Age-adjusted body mass index (BMI)	
Underweight (BMI <18)	79 (12.2)
Healthy weight (BMI 18–24.9)	474 (73.0)
Overweight (BMI 25–29.9)	73 (11.3)
Obese (BMI ≥30)	23 (3.5)
Age (years)	4.0±0.7; 4.0 to 4.1
BMI (kg/m ²)	20.2±3.7; 20.0 to 20.5
Dietary intake per lunch n=436	
Vegetables/fruit (g)	64.1±48.5; 59.6 to 68.7
Vegetables/fruit excluding potatoes (g)	42.9±38.3; 39.3 to 46.5
Calories (kcal)	288.2±125.7; 276.4 to 300.0
Fibre (g)	2.7±1.4; 2.5 to 2.8
Sugar (g)	13.7±12.0; 12.6 to 14.8
Fat (g)	8.8±4.4; 8.4 to 9.2
Sodium (mg)	487.4±292.2; 459.8 to 514.9
Physical activity (PA) per day n=624	
Total PA (min/day)	171.9±55.6; 167.5 to 176.2
Moderate to vigorous intensity PA (min/day)	9.7±9.3; 9.0 to 10.5
Light intensity PA (min/day)	162.2±53.6; 158.1 to 166.4
Sedentary time (min/day)	306.7±59.4; 302.0 to 311.3
Centre-level characteristics n=50	
Socioeconomic status of the region	\$30 473±\$6805; \$28 587 to \$32 359
School district	
Anglophone	32 (64)
Francophone	18 (36)
Rurality	
Rural	19 (38)
Urban	31 (62)
Number of children in the childcare centre	23±11; 20 to 26
Childcare educators' practices (range)*	
Modelling (0–9 points)	4.9±1.4; 4.7 to 5.0

Continued

Table 1 Continued

	n (%) Mean±SD; 95% CI
Nutrition education (0–6 points)	1.9±1.5; 1.7 to 2.0
Satiety recognition (0–12 points)	5.1±1.8; 4.9 to 5.2
Verbal encouragement (0–9 points)	3.2±1.8; 3.0 to 3.3
No use of food as rewards (0–3 points)	2.8±0.5; 2.8 to 2.9
Overall nutrition practices (0–39 points)	17.8±4.0; 17.5 to 18.2
Informal PA promotion (0–9 points)	4.6±2.6; 4.4 to 4.8
Formal PA promotion (0–9 points)	6.2±2.1; 6.0 to 6.4
Overall PA practices (0–18 points)	10.8 (4.1) 10.5 to 11.1

*High scores indicate healthier practices.

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 modelled healthy eating.⁴³ Our study findings probably reflect the nutritional composition of the foods served in the childcare centres. 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 centres consume excess amounts of added sugars.^{44 45} Thus, for modelling to be effective at promoting healthy eating, it is essential for childcare centres 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.⁴⁶ 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.⁴⁷ Providing evidence-based nutrition education to educators 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 reward⁴⁸ or combining positive reinforcement and a tangible reward (ie, sticker)⁴⁹ was an effective way of increasing children's intake of 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

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

Educators' nutrition practices	Vegetables and fruit (g)		Vegetables and fruit without potatoes (g)		Calories (kcal)		Fibre (g)		Sugar (g)		Fat (g)		Sodium (mg)	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Modelling	0.042	-0.07 to 0.48	0.001	-0.18 to 0.25	0.366	0.00 to 1.42	0.065	-0.001 to 0.14	0.141	0.03 to 0.27	0.004	-0.27 to 0.04	0.180	-0.762 to 2.69
Nutrition education	-0.038	-0.42 to 0.07	-0.01	-0.31 to 0.10	-0.456	-1.46 to -0.02	-0.066	-0.12 to -0.01	-0.081	-0.17 to 0.019	-0.009	-0.04 to 0.00	-0.951	-4.33 to 0.02
Satiety recognition	0.001	-0.13 to 0.17	0.000	-0.14 to 0.14	-0.001	-0.28 to 0.20	0.011	-0.04 to 0.06	0.013	-0.08 to 0.11	-0.000	-0.01 to 0.01	0.008	-0.79 to 1.12
Verbal encouragement	0.060	-0.01 to 0.37	0.000	-0.12 to 0.14	-0.021	-0.37 to 0.11	0.015	-0.04 to 0.07	0.027	-0.06 to 0.12	-0.001	-0.01 to 0.00	-0.591	-2.79 to 0.02
Not using food rewards	-0.001	-2.16 to 2.02	0.355	-0.62 to 3.920	-1.248	-8.53 to 0.46	-0.023	-0.21 to 0.20	-0.075	-0.34 to 0.30	-0.144	-0.52 to -0.002	-0.042	-15.21 to 12.25
Overall nutrition practices	0.002	-0.01 to 0.04	0.000	-0.02 to 0.02	-0.004	-0.07 to 0.02	0.003	-0.02 to 0.03	0.011	-0.03 to 0.05	-0.000	-0.003 to 0.000	-0.04	-0.36 to 0.04

Estimates are adjusted for province, rurality, socioeconomic status of the region and number of children in the childcare centre. Boldface indicates statistical significance ($p < 0.05$). Fixed effect variance ranged from 1.64% to 14.8%. Random effect variance ranged from 24.3% to 47.9%.

Table 3 Multilevel linear regression-derived estimates of the association between educators' practices and children's physical activity (PA)

Educators' PA promotion practices	Total PA (min/day)		Moderate to vigorous PA (min/day)		Light intensity PA (min/day)		Sedentary activity (min/day)	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Formal PA promotion	-0.382	-4.05 to 3.30	-0.024	-0.07 to 0.02	0.280	-3.14 to 3.71	0.002	-0.01 to 0.01
Informal PA promotion	-0.748	-4.43 to 2.96	0.004	-0.98 to 0.05	-0.524	-3.97 to 2.94	0.003	-0.01 to 0.01
Overall PA practices	-0.388	-2.54 to 1.78	-0.007	-0.03 to 0.02	-0.082	-2.10 to 1.94	0.001	-0.01 to 0.01

Estimates are adjusted for province, rurality, socioeconomic status of the region and number of children in the childcare centre. Fixed effect variance ranged from 1.7% to 4.6%. Random effect variance ranged from 11.6% to 19.7%.

another has been linked to an enhanced preference for the food used as a reward, while the preference for the distasteful food decreases.^{50 51} Therefore, it is suggested that verbal rewards be used rather than tangible rewards.⁵²

Although previous studies have found that verbal encouragement^{48 49} and encouraging preschoolers to eat healthy foods while allowing them to make their own food choices⁵³ increased their consumption of fruit and vegetables, verbal encouragement was not associated with children's dietary intake in our study. This could be due to the children's overall appreciation of the foods served at lunch, as it has been suggested that verbal encouragement is more effective in promoting the consumption of disliked foods than that of foods already enjoyed by children. Similarly, while satiety recognition practices were not associated with children's dietary intake in our study, they may help promote positive feeding behaviours and a pleasant emotional climate at mealtimes.⁵³

Educators' PA promoting practices and children's PA levels

Our study found no association between educators' PA practices and children's PA levels. The results from previous studies are inconsistent.¹¹ While some studies found that offering portable play equipment can increase PA,^{15 16 54-56} one found that not withholding PA as a means of punishment was not associated with preschoolers' PA.¹⁵ Another reported a decrease in children's PA when childcare educators were present.⁵⁷ Other variables may have a larger influence on children's choice to be physically active, such as the PA levels of their peers,⁵⁸ or if they feel like being active or not on a particular day. It is also possible that our findings are a consequence of how the PA items of the NAP SACC were grouped. For example, children's PA may be associated with some informal or formal practices but not others. Although our results showed no statistically significant effect, 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 PA. A recent study found that PA opportunities accounted for only 48min or 12% of the total childcare day.²⁰ 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.²⁰ In line with findings of other studies, our results showed room for improvement as children spent a large amount of time in sedentary activities.^{20 59 60}

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 behaviours 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 2 days of data collection and children's PA was assessed through the entire day. This disconnect is likely to have obscured any punctual association between educators' 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 educate childcare educators on how they can play a role in helping children become more physically active, by providing them with training in PA.⁶¹⁻⁶³ 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 educators' practices by trained research assistants and the diversity of childcare centres in terms of geographical location, language spoken and socioeconomic status. However, its limitations must be acknowledged. Multiple testing, as was done in this study, may have incorrectly rejected the null hypothesis, thus yielding false statistically significant results.⁶⁴ Therefore, confirmatory studies which aim to provide definite proof and guide decision making should use appropriate procedures for multiple test adjustments.⁶⁴ Children's dietary data were collected on only 2 days, which may not be enough to represent preschoolers'

usual intake since it can fluctuate from day to day.⁶⁵ Also, only two childcare centres were observed to use food as rewards. Therefore, our finding may not be generalisable to centres which commonly use this practice. Since PA and dietary intake were only assessed during childcare hours, it is not possible to know if childcare educators' practices can impact children's activity and eating patterns outside the childcare centre. Parental eating and PA behaviours should also be assessed in future studies, as aligning parents and educators' practices may reinforce positive eating and PA behaviours of children throughout the entire day. It is also possible that the presence of the research assistants influenced the childcare educators' practices and children's behaviours. Furthermore, we used census data from the region in which childcare centres were located as a measure of socioeconomic status, which may be different from the actual socioeconomic status of the children attending the centres. 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 behaviours, 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, the 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 centres.

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Contributors SW conceived the study, collected, analysed and interpreted the data. MB conceived the study and interpreted the data. NC and DD interpreted the data. HV, NM, RE-S, AL and MLH 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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