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Research report

How well do preschoolers identify healthy foods? Development and preliminary validation of the Dietary Interview Assessing Nutritional Awareness (DIANA) ☆

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ABSTRACT

The current study aimed to develop and initially validate a brief Dietary Interview Assessing Nutritional Awareness (DIANA) that mapped onto the Stop-Light Diet System. Participants for this study included 69 preschool children (83% boys; mean age = 5.13 years; 86% Latino) recruited from two summer programs. Children were presented with 24 pictures and were asked to name the food and indicate how healthy they felt each food was by pointing to a smiley face (very healthy = Green/Go food), neutral face (somewhat healthy = Yellow/Slow food), or a sad face (not healthy at all = Red/Whoa foods). Psychometric properties of the DIANA were assessed via a baseline assessment while children were re-administered the DIANA within 4–6 weeks to ascertain the test–retest reliability. Discriminant validity was also assessed in an exploratory fashion with a small subsample ($n = 11$) of children who participated in a healthy-lifestyle intervention program (HIP). Results indicated that the internal consistency of the DIANA for both the expressive knowledge and the health classification scales was acceptable ($\alpha = .83$ and .82, respectively) along with the test–retest reliability (ICC = .86 and .81, respectively). Lastly, children who participated in HIP experienced greater gains in their ability to classify food based on the Stop-Light System and greater expressive knowledge of Green/Go foods compared to children who did not participate in the intervention suggesting adequate construct validity. These findings highlight the feasibility and utility of the DIANA in assessing young children's knowledge of foods and their relative healthiness as well as its potential sensitivity to intervention effects.

Introduction

Approximately 25% of children ages 2 to 5 years are classified as overweight (BMI between 85th and 95th%ile for age and gender) or obese (BMI >95th%ile) with that figure increasing to over 35% among school age children (Ogden, Carroll, Kit, & Flegal, 2012). Children from ethnic minority groups are at an even greater risk for obesity, with nearly 40% of Latino children classified as overweight by age 6 (Cossrow & Falkner, 2004; Ogden et al., 2012). Health risks and associated societal costs of pediatric obesity are well established (Hannon, Rao, & Arslanian, 2005; Lobstein, Baur, & Uauy, 2004) with related health care expenditures expected to reach almost 20% in the U.S. by 2030 (Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008). Given the high stability rates of pediatric obesity (Daniels, 2006; Freedman et al., 2005), a significant amount of research has been devoted toward the development of early interventions (Campbell & Hesketh, 2007).

Pediatric obesity interventions

Developed over 25 years ago, behavioral family-based interventions have both short-term and long-term results supporting their efficacy in improving weight related health outcomes (see Epstein, Paluch, Roemmich, & Beecher, 2007 for a review). Regardless of the type of behavioral family-based intervention, the core features involve addressing activity levels as well as eating patterns in the child and parent (Collins et al., 2011). Given the importance of dietary behavior, specifically reducing caloric intake toward achieving a better energy balance, it is not surprising that a major focus of family-based treatments is exposing families to healthier foods and helping them reduce portion sizes (Epstein et al., 2007). The Stop-Light Diet System is a widely used tool within behavioral family-based interventions to aid families in promoting healthier choices. According to the Stop-Light Diet System, food is categorized according to traffic light colors with green foods being high on nutrients, very low in calories and fat (<2 g), yellow foods being moderate in calories for nutrients provided (2–5 g of fat), and red foods being high in calories with low nutrient content and higher than 5 g of fat (Epstein & Squires, 1988). To further aid parents in

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implementing the Stop-Light Diet System, the U.S. Department of Health and Human Services (DHHS) during the We Can! Campaign classified foods as "Go," "Slow," and "Whoa," which corresponded to the Green light ("Go"), Yellow light ("Slow"), and Red light ("Whoa"). The effectiveness of the Stop-Light Diet System for improving children and adult's dietary intake has been documented across studies (Epstein, Myers, Raynor, & Saelens, 1998; Epstein et al., 2007) as it targets families' nutritional knowledge and/or awareness.

Nutritional knowledge

Nutritional knowledge is a broad concept that may be defined as the knowledge of current dietary recommendations, sources of nutrients, healthy food choices, and diet–disease links (Parmenter & Wardle, 1999). Not surprisingly, assessing nutritional knowledge can be challenging as tests vary tremendously (Parsons, Power, Logan, & Summerbell, 1999) with some being narrow in scope and only assessing certain domains such as fat (Steenhuis, Brug, Van Assema, & Imbos, 1996), or fat, fiber, and cholesterol (Resnicow et al., 1997). Other questionnaires may be specific to a particular field such as sports related nutrition (Zinn, Schofield, & Wall, 2005). Given the interest in linking knowledge to actual dietary behaviors, a key component of any nutritional knowledge test is assessing whether an individual can differentiate and/or identify foods of varying health content (Parmenter & Wardle, 1999).

Given that parents are the vehicles of change for children's dietary intake (Collins et al., 2011; Golan & Crow, 2004), it is not surprising that significantly less research has focused on measuring children's nutritional knowledge. However, in light of recent national health initiatives (e.g., United States' Let's Move) as well as school wide intervention efforts, researchers have more recently started to examine children's awareness of healthy foods and whether it promotes better choices (Khambalia, Dickinson, Hardy, Gill, & Baur, 2012). In middle school, a large randomized trial of a nutrition curriculum implemented by trained health teachers showed that the intervention group significantly improved their nutrition knowledge and subsequently their eating behaviors (e.g., eating more fruits and vegetables) compared to the control group (Fahlman, Dake, McCaughtry, & Martin, 2008). School wide interventions in elementary schools such as The Child and Adolescent Trial for Cardiovascular Health (CATCH) as well as The Kid's Choice Program (KCP) have also documented via randomized trials improvements in children's self-reported daily energy intake from fat (Luepker et al., 1996) as well as increases in fruits/vegetables, healthier drinks, and increased physical activity compared to control schools (Hendy, Williams, & Camise, 2011). A nutrition education program with 4th grade children also showed positive effects in terms of improvements in nutritional knowledge predicting changes in subsequent dietary behaviors and anthropometric measures (Lee, Lee, Chang, & Kim, 2009).

Prevention efforts in younger preschool children within child care settings have also gained attention (D'agostino, D'andrea, Nix, & Williams, 1999; Larson, Ward, Neelon, & Story, 2011; Story, Kaphingst, & French, 2006). Health education programs within preschools have documented gains in terms of children's willingness to try new foods (Johnson, Bellows, Beckstrom, & Anderson, 2007) and increasing the consumption of fruits and vegetables (Witt & Dunn, 2012). Family-based behavioral interventions also expose children as young as preschool age to nutritional education, although parents continue to be the main target of treatment (Boles, Scharf, & Stark, 2010; Stark et al., 2011). In terms of measuring nutritional knowledge, the few studies with preschoolers have primarily used a dichotomous categorization in terms of showing children pairs of food/snacks and asking children to pick the healthy or unhealthy ones (Başkale & Bahar, 2011; Nguyen, 2008; Sigman-Grant et al., 2014). For example, using an intervention/comparison study design, Sigman-Grant et al. (2014) showed 191 preschoolers nine food pairs and asked them to "point to the healthy choice – the food that helps keep your heart, muscles, and bones, strong." They found that children who participated in a nutrition education program (All 4 Kids) were significantly more likely to distinguish healthy-foods at the post-treatment compared to children in the comparison/no intervention group. This dichotomous categorization is analogous to the Green/Go vs. Red/Whoa of the Stop-Light Diet System that is often used within obesity interventions. While using a food pairing approach is beneficial in terms of being less cognitively taxing on young children (Sigman-Grant et al., 2014), a limitation is that it only indirectly measures children's nutritional knowledge of a certain food as he or she is merely required to pick the better "healthier" choice. Most importantly, a dichotomous food/pairing approach does not allow an assessment of children's ability to understand moderately healthy foods (i.e., the Yellow/Slow aspect of the Stop-Light Diet System). Development of a more direct and thorough nutritional knowledge measure for young children (e.g., present each food item individually to children and ask them the healthiness of each item on a scale that maps onto all three colors of the Stop-Light Diet System) may facilitate the assessment of rapidly emerging school wide initiatives.

Finally, children's nutritional knowledge may be viewed as a proxy for the family health environment and extent to which parents socialize and teach children about healthy food choices. For example, during family-based pediatric obesity interventions, parents are the targets of treatment and are encouraged to implement nutritional changes, often times via the Stop-Light Diet System, in their children (Golan & Crow, 2004). However, it is often difficult to measure how successful parents are in implementing such changes as self-monitoring food diaries, while a helpful and effective strategy (Boutelle & Kirschenbaum, 1998), are inconsistently implemented by parents. For instance, Germann, Kirschenbaum, and Rich (2007) found that only 40% of parents self-monitored during the course of a family-based obesity treatment for low-income minority children. Hence, measuring change in children's nutritional knowledge, in particular with an assessment that maps onto to the Stop-Light Diet System learned by parents, may offer an indirect way to determine how successful parents are being in implementing nutritional changes at home across the entire family.

Current study

The goal of the current study was to develop and provide preliminary evidence for the validity of a brief Dietary Interview Assessing Nutritional Awareness (DIANA) for preschoolers. The DIANA was designed to cover children's basic expressive knowledge of various foods represented across dietary categories (e.g., fruits, vegetables, fat) as well as their perception of each food's healthiness. Expanding on previous work showing that preschool children can differentiate between Green/Go and Red/Whoa foods (Sigman-Grant et al., 2014), the current study was interested in determining whether young children can understand the health content of foods beyond a simple dichotomous manner (healthy vs. unhealthy) to include foods that are healthy in moderation (i.e., Yellow/Slow foods). Hence, items and responses on the DIANA mirrored all aspects of the Stop-Light Diet System (Green/Go, Yellow/Slow, Red/Whoa foods). Finally, in an exploratory fashion and to provide divergent validity for the DIANA, a small subsample of children who participated in a healthy-lifestyle intervention was compared to a group of children who did not receive any nutritional related intervention.

Method

Item generation

Upon reviewing the pediatric obesity literature as well as existing nutritional knowledge tests for preschool children (Başkale & Bahar, 2011; Sigman-Grant et al., 2014), it was decided that a test for younger children should be conducted in an interview format (to maximize comprehension of test items) and assess basic knowledge of various types of food (e.g., fruit, vegetables) and children's perceptions on each food's healthiness. Each test item was designed to be accompanied by a large colorful picture depicting the food being assessed. Part A (*expressive knowledge*) of the test would ask children to simply name the food item as a way to measure their basic knowledge of various foods while Part B *(health classification*) asked children to receptively indicate the healthiness of each food. Item choices for Part B of the test were created to mirror the entire range of the Stop-Light Diet System: Green/Go foods, Yellow/Slow foods, and Red/Whoa foods. Similar to sociometric procedures employed with preschool children when interviewed about their classmates (Asher, Singleton, Tinsley, & Hymel, 1979), children were presented with a Smiley Face and were told that this answer should be given for food items they think are very healthy for them (regardless of whether they liked to eat the food), a Neutral Face which indicated that the food item was somewhat healthy for them, and a Sad Face which indicated that the food item was not healthy at all for them (regardless of whether they liked to eat the food). To maximize the content validity of the items, the literature on the Stop-Light Diet System and other pediatric obesity interventions were reviewed along with dietary guidelines for young children (e.g., MyPlate recommendations).

An original list of 40 items was created tapping into various Green/Go foods (e.g., fruit, vegetables), Yellow/Slow foods (e.g., spaghetti, bread, meat), and Red/Whoa foods (e.g., ice-cream, soda). A group of expert professionals (pediatrician, nutritionist, exercise physiologist, and pediatric psychologists) that are involved in pediatric obesity treatment and parents of young children reviewed the original item list. Based on their recommendations, a) drinks were removed from the list (e.g., soda, orange juice, water) given the lack of clarity of the pictures, b) the number of items were reduced (e.g., removed orange, strawberry, french-fries, doughnuts, sushi, shrimp) to make the administration time quicker given the targeted age range, and c) items were retained such that each category had a mix of "easy" food items that young children should be familiar with while still maintaining some more "difficult" food items that they may not be as familiar with. Furthermore, during the review of the original 40 items, parents suggested the addition of a more ethnically appropriate item for Latino families under the Yellow/Slow food category (rice/beans). These suggestions led to a final list of 24 items (see Table 1) which was created with 12 items present for *Green/Go foods*, and 6 each for *Yellow/Slow foods*, and *Red/Whoa foods*. The DIANA, including all picture stimuli, is readily available from the author upon request. It is important to note that the original intent of the DIANA was to have an equal number of items from each *Green/Go*, *Yellow/Slow*, and *Red/Whoa* category and that the reason 12 items remained under the "Green/Go" category was to have an equal representation of 6 fruits and 6 vegetables which the group of experts felt was important to maintain, especially given that most interventions focus on increasing children's consumption of these *Green/Go foods.*

Lastly, the expert group provided valuable information as to the appropriate scoring of the test. While Part A is scored as correct (scored as 1) or incorrect (scored as 0), the group provided alternative verbal answers that should be counted as correct based on the pictures. For example, under the item depicting a "Salmon," a response of any fish would be counted as correct. In Part B of the test, the group felt it was important to award partial credit responses within the Green/Go and Red/Whoa foods. For example, a child who correctly points to the smiley face ("very healthy") for a fruit would get two points while pointing to the neutral face ("somewhat healthy") would earn one point, followed by zero points for a child pointing to the sad face ("not healthy at all").

Table 1
Item difficulty, item discrimination, and internal consistency of the DIANA.

Scale name and items	Item difficulty % correct		Scale alpha/Item correlation to scale	
	Part A	Part B	Part A	Part B
Green/Go foods	49.3%	54.6%	α = .71	α = .83
1. Apple	94%	74%	.28*	.33**
3. Cauliflower	7%	31%	.46***	.476***
5. Carrots	94%	55%	.466***	.666***
6. Lettuce	26%	53%	.36**	.536***
9. Banana	97%	63%	.446***	.476***
11. Tomato	65%	57%	.576***	.496***
12. Onions	17%	32%	.596***	.606***
15. Grapes	67%	64%	.576***	.706***
19. Pear	25%	58%	.716***	.736***
21. Papaya	7%	49%	.466***	.776***
23. Broccoli	74%	60%	.516***	.66***
24. Kiwi	19%	59%	.52***	.60***
Yellow/Slow foods	66.2%	14.7%	α = .62	α = .60
7. Bread	74%	16%	.55***	.43***
13. Cheese	93%	19%	.57***	.38**
14. Pasta	73%	14%	.63***	.63***
16. Turkey	75%	16%	.68***	.54***
17. Salmon	20%	13%	.43***	.59***
22. Rice/beans	62%	11%	.68***	.46***
Red/Whoa foods	75.4%	24.4%	α = .60	α = .62
2. Bacon	28%	28%	.55***	.49***
4. Pizza	97%	15%	.63***	.54***
8. Hot-dog	90%	23%	.57***	.64***
10. Chocolate	73%	30%	.58***	.62***
18. Burger	71%	31%	.63***	.60***
20. Ice-cream	94%	23%	.71***	.64***
Overall Score	60.1%	36.7%	α = .83	α = .82

Note: Part A = expressive knowledge, Part B = health classification.
***$p < .001$, **$p < .01$, *$p < .05$.

Pilot sample

The pilot study for examining the psychometric properties of the trimmed 24-item DIANA took place in a large urban southeastern city in the U.S. with a large Latino population. Children and their caregivers were recruited from local preschool and mental health agencies via brochures, radio and newspaper ads, and open houses/parent workshops. Interested parents were asked to call or speak with study staff to have the study explained to them and schedule a screening appointment to determine eligibility. To qualify for the study participants were required to (a) have an estimated IQ of 70 or higher ($M = 88.97$, $SD = 12.08$) based on the Wechsler Preschool and Primary Scale of Intelligence – Fourth Edition (WPPSI-IV; Wechsler, 2012) (b) have no confirmed history of Autistic or Psychotic Disorder based on parent report, and (c) be enrolled in a full-time preschool program. Additionally, all children in the present study were participating in a larger trial of a 4 or 8-week summer treatment program for pre-kindergarteners (STP-PreK) targeting school readiness ($n = 58$) or an 8-week healthy-lifestyle intervention program (HIP; $n = 11$).

A description of the STP-PreK and results of an open trial are reported elsewhere (Graziano, Slavec, Hart, Garcia, & Pelham, 2014). Of note, children who participated in the STP-PreK did not receive any nutritional related intervention. By contrast, HIP (Graziano, Lim, & Garcia, 2014) consisted of a Healthy-Lifestyle Summer Camp (HLSC) as well as a Healthy-Lifestyle Parenting Program (HLPP). The

HLSC ran from 8 a.m. to 5 p.m. (Monday–Friday) with children participating in several periods of physical activity/fitness, life skills (to promote social-emotional functioning), nutrition education, literacy activities, as well as an art period. Children engaged in educational yet fun hands-on group activities aimed at practicing various healthy habits (e.g., chewing slowly). They also learned how to moderate their food consumption and understanding of food's nutritional content via the Stop-Light System. These activities were age appropriate and included the use of colorful friendly puppets that represent different food groups (modeled after USDA's MyPlate dietary guidelines). Children were also exposed and encouraged to try one new healthy food a day. The physical activity/fitness component entailed children participating in various group-based aerobic exercises to increase interest in physical play rather than serve as an extreme weight loss program. The physical activity/fitness, behavioral and social-emotional curriculum used in the summer program was adapted from STP-PreK (Graziano, Slavec et al., 2014). The behavioral modification program used the point system from the STP-PreK in which children earn points for engaging in healthy behaviors (e.g., trying healthy food, participating in group physical activities), behaviors that indicate good self-control skills (e.g., paying attention during group discussion on nutrition), and prosocial behaviors (e.g., sharing). It is important to note that the purpose of the behavioral modification system was to increase children's enjoyment of healthy activities by providing concrete reinforcements for any attempts and participation in such activities rather than to reinforce extraneous effort or weight loss. Points earned were then used for daily and weekly rewards including special recess activities (e.g., playing Xbox Kinect).

The most crucial aspect of HIP was the integration of parental engagement and involvement. At this young age, parents represent the vehicle of change for long term success (Golan & Crow, 2004). Hence, parents received daily verbal and written feedback from counselors regarding a) their child's health, behavioral, and academic progress at camp and b) their own progress in terms of providing their children with a healthy lunch. Parents also participated in a weekly HLPP in which they learned behavioral modification strategies, adapted from Parent–Child Interaction Therapy (Eyberg & Hood, 2003), to support their child to engage in healthier eating and physical activity habits. Important topics include attending to desired behavior (e.g., trying healthy foods) via labeled praises, differential attention (e.g., ignoring pleas for unhealthy snacks), and giving effective commands. Parents were also taught to monitor and limit sedentary activities that increase caloric intake (e.g., television/video games) while promoting physical activity. Finally, parents were taught the Stop-Light Diet System (Epstein & Squires, 1988) to improve their family's nutrition. The specifics for each period of the HLSC and each session of the HLPP are detailed in a manual available from the authors.

For the purposes of the present study, children participating in either summer camp intervention (STP-PreK or HIP) were combined for a final sample of 69 children (83% boys) whose parents provided informed consent to participate in the study. The mean age of the participating children was 5.13 years (range 3.78 to 6.90 years, $SD = 7.8$ months) with Hollingshead SES scores in the lower to middle class range ($M = 42.47$, $SD = 13.09$). In terms of the ethnic and racial makeup, 86% of the children were Latino-White, 13% were Non-Latino White, and 1% African-American. Fifty-nine percent of children were from an intact biological family, 22% from a divorced/separated household, 18% were from a single biological parent household, and 1% were in an adoptive/foster family placement. Forty-five percent of the sample were referred by a pediatrician/physician or mental health professional, 29% were self-referred, while the remaining 26% were referred by school personnel. Of note, children participating in HIP had higher body mass index z-scores, $F(1, 66) = 5.22$, $p < .05$ ($M = 1.33$, $SD = 1.09$) and were slightly older, $F(1,67) = 5.90$, $p < .05$ ($M_{age} = 5.5$ years., $SD = 1.06$) compared to children in the STP-PreK (Mean BMI z-score .43, $SD = 1.22$ and $M_{age} = 5.05$, $SD = .52$, respectively). No other significant differences in demographics, including child IQ, were found for children participating in the different summer camps.

Study design and procedure

This study was approved by the university's Institutional Review Board. All children were administered the DIANA by graduate level trained research assistants prior to the start of the STP-PreK or HIP. Sixty-seven out of the 69 families (97%) completed the DIANA a second time (for test–retest reliability) during the last week of camp (4–6 weeks after the initial completion). Other than receiving the summer camps for free or at a subsidized cost via a local grant, families did not receive any additional compensation for completing the DIANA.

Data analysis plan

Descriptive data were first provided to demonstrate the difficulty of items on the DIANA. The internal consistency of the DIANA, including Part A (*expressive knowledge*), Part B (*health classification*), and proposed subscales (Green/Go, Yellow/Slow, Red/Whoa), was evaluated by computing Cronbach's alpha coefficients. Alphas of .70 or greater provide evidence of adequate internal consistency (Clark & Watson, 1995; Kline, 2013). Additionally, each item was correlated with the subscale score as correlations below 0.2 are considered a cut-off point for discarding an item (Streiner & Norman, 2008). Test–retest reliability of the DIANA Part A and B as well as subscales was examined by computing Pearson r's as well as an Intraclass Correlation Coefficient (ICC) between the DIANA scores obtained 4 to 6 weeks apart (before the start of STP-PreK or HIP and at the last week of the camps). The discriminant validity of the DIANA was examined in an exploratory fashion by comparing scores of the DIANA completed by a small subsample ($n = 11$) of children who participated in the healthy-lifestyle intervention (HIP) compared to the group of children ($n = 59$) who did not receive any nutritional related intervention (STP-PreK). Linear regression analysis examined the DIANA's sensitivity to treatment-related change by evaluating the contribution of participant condition (dummy coded HIP = 1 vs. STP-PreK coded as 0) in the prediction of post scores, after accounting for the predictive contribution of baseline scores. This regression methodology of controlling for baseline scores rather than computing raw change scores is consistent with statistical recommendations (Vickers & Altman, 2001).

Results

Item difficulty

Given that the DIANA was designed for young children, it was first important to establish children's familiarity with each of the 24 pictured food items as well as their difficulty in categorizing each food's relative healthiness. Typically, scale developers suggest that items should be correctly completed by between 20 and 80% of participants as too low or too high numbers would suggest that the item may be too difficult or too easy for inclusion (Kline, 2013). As seen in Table 1 which includes all 24 items, the average percentage of items correctly named by children in Part A (*expressive knowledge*) was 60.08% (range 7%–97%). Of note, children were significantly less likely to correctly name Green/Go healthy foods compared to all other subscales ($p < .001$) while Red/Whoa foods had the highest correct percentage compared to all other subcategories ($p < .001$). In terms of Part B (*health classification*), the average percentage of items correctly classified (very healthy = Green/Go, somewhat healthy = Yellow/Slow, and not healthy at all = Red/

Table 2
Means and test–retest reliability.

Subscales		Time 1		Time 2		Pearson r	Intraclass Correlation Coefficient (ICC)
		Mean (SD)	Min–Max	Mean (SD)	Min–Max	(Time1–Time2)	(Time1–Time2)
Green/Go foods	Part A	5.79 (1.96)	1.00–11.00	6.34 (2.07)	0–10.00	.73***	.84
	Part B	14.59 (5.98)	0–24.00	14.04 (7.06)	0–24.00	.59***	.74
Yellow/Slow foods	Part A	4.00 (1.39)	0–6.00	4.11 (1.50)	0–6.00	.67***	.80
	Part B	0.88 (1.01)	0–4.00	.96 (.98)	0–4.00	.22	.36
Red/Whoa foods	Part A	4.53 (1.13)	0–6.00	4.84 (1.09)	0–6.00	.56***	.72
	Part B	3.91 (2.95)	0–12.00	3.89 (3.07)	0–11.00	.55***	.71
Overall Score	Part A	14.33 (3.57)	1.00–21.00	15.29 (3.98)	0–21.00	.76***	.86
	Part B	19.38 (6.63)	2.00–35.00	18.89 (8.52)	1.00–37.00	.70***	.81

Note: Part A = expressive knowledge, Part B = health classification.
***$p < .001$, **$p < .01$, *$p < .05$.

Whoa) was 36.68% (range 13%–74%) with Green/Go foods having the highest percentage (54.6%), followed by Red/Whoa foods (24.4%) and Yellow/Slow foods (14.7%) with all subscales being significantly different from one another ($p < .001$). Overall, it appears that the difficulty level across both Parts A (*expressive knowledge*) and B (*health classification*) is within the suggested range allowing a broad assessment of nutritional knowledge among young children.

Lastly, multivariate analyses indicated that children's performance across the items did not vary according to gender, SES, or full scale IQ. However, not surprisingly children's age was associated with performance on the DIANA with older children obtaining higher scores across all Part A (*expressive knowledge*) subtests, including Green/Go foods ($r = .36$, $p < .01$), Yellow/Slow foods ($r = .40$, $p < .01$), Red/Whoa foods ($r = .33$, $p < .01$), Total Score ($r = .43$, $p < .001$), as well as the overall Part B (*health classification*) score ($r = .29$, $p < .05$).

Internal consistency

Internal consistency was good for the overall scores in both Part A and Part B ($\alpha = .83$ and .82, respectively). Additionally, when examining individual subscales, adequate to good consistency was found for Green/Go foods for both Part A and Part B ($\alpha = .71$ and .83, respectively).

Marginally adequate consistency was found for the Yellow/slow foods and Red/whoa foods subscales across both parts ($\alpha = .60$–.62). Of note, removal of any individual item did not yield improved overall internal consistency across these two subscales. Additionally, and as seen in Table 1, all of our items correlated moderately well with its corresponding subscale (Mean $r = .55$, range: .28–.71 for Part A and Mean $r = .57$, range: .33–.77 for Part B). Hence, no item was removed.

Test–retest reliability

As seen in Table 2, test–retest reliability estimates were good for the overall scores in both Part A and Part B (ICC = .86 and .81, respectively). Additionally, when examining individual subscales, adequate to good test–retest reliability was found for the Green/Go foods and Red/Whoa foods subscales for both Part A and Part B (ICC range: .71–.84). Within the Yellow/Slow foods subscale, good test–retest reliability was found for Part A (ICC = .80) but was inadequate for Part B (ICC = .36).

Discriminant validity and sensitivity to intervention

As seen in Table 3, the subgroup of children who participated in the healthy-lifestyle intervention (HIP) scored significantly better on Part B (health classification) in terms of their overall score and all subtests as well as Part A (expressive knowledge) of the Green/Go subscale during the second administration of the DIANA (which took place during the last week of the intervention) compared to children who participated in the non-nutritional camp

Table 3
Differences in scores between children participating in HIP versus STP-PreK.

Subscales		Pre-HIP[a] ($n = 11$)	Pre-STP-PreK[b] ($n = 58$)	Post-HIP[c] ($n = 11$)	Post-STP-PreK[d] ($n = 56$)	Contrasts
		Mean (*SD*) Min–Max	Mean (*SD*) Min–Max	Mean (*SD*) Min–Max	Mean (*SD*) Min–Max	*F* score
Green/Go foods	Part A	6.63 (2.98) 0–11.00	5.80 (1.98) 1.00–11.00	8.73 (3.38) 0–12.00	6.34 (2.07) 1.00–10.00	[ab] 1.43, [cd] **9.72*****; [ac] **44.08*****, [bd] **7.13***
	Part B	15.91 (7.41) 2.00–23.00	14.60 (6.13) 0–24.00	20.55 (4.16) 13.00–24.00	14.04 (7.06) 0–24.00	[ab] 1.75, [cd] **8.67****; [ac] **4.60** +, [bd] .477
Yellow/Slow foods	Part A	3.81 (1.94) 0–6.00	3.96 (1.40) 0–6.00	4.09 (1.76) 0–6.00	4.11 (1.50) 0–6.00	[ab] .14, [cd] .001; [ac]1.96, [bd] .82
	Part B	.90 (1.37) 0–4.00	.84 (1.00) 0–4.00	1.90 (1.83) 0–5.00	.96 (.98) 0–4.00	[ab] .003, [cd] **5.39***; [ac]1.96, [bd] .586
Red/Whoa foods	Part A	4.45 (1.81) 0–6.00	4.52 (1.14) 0–6.00	4.91 (1.81) 0–6.00	4.84 (1.09) 0–6.00	[ab] .038, [cd] .030; [ac] **4.81** +, [bd] **5.29***
	Part B	3.91 (3.08) 1.00–11.00	3.95 (2.96) 0–12.00	8.45 (4.08) 1.00–12.00	3.89 (3.07) 0–11.00	[ab].079, [cd] **18.07***** ; [ac] **15.28****, [bd] .02
Overall Score	Part A	14.91 (6.43) 0–22.00	14.29 (3.62) 1.00–21.00	17.73 (6.72) 0–24.00	15.29 (3.98) 0–21.00	[ab] .184, [cd] 2.70; [ac] **24.52****, [bd] **7.90****
	Part B	20.63 (9.12) 3.00–37.00	19.38 (6.80) 2.00–35.00	30.82 (8.22) 19.00–40.00	18.89 (8.52) 1.00–37.00	[ab]1.71, [cd]**18.17***** ; [ac] **9.85****, [bd] .346

***$p < .001$, **$p < .01$, *$p < .05$, + p <.10.
Part A = expressive knowledge, Part B = health classification, HIP = Healthy-Lifestyle Intervention Program, STP-PreK = Summer Treatment Program for Pre-kindergarteners.

Table 4
Model for testing sensitivity of the DIANA to intervention effects.

	β		T-value		Model R^2		R^2 change		F change	
	Part A	Part B	Part A	Part B	Part A	Part B	Part A	Part B	Part A	Part B
T2 Green/Go foods										
Step 1. T1 Green/Go	.71***	.47***	9.23	4.69	.65	.36	.65	.36	37.94***	11.74***
Age	.13	.12	1.70	1.15	–	–	–	–	–	–
BMI-Z score	.00	.17	.026	1.63	–	–	–	–	–	–
Step 2. Intervention (HIP)	.22**	.23*	3.55	2.16	.69	.41	.04	.05	8.34**	4.66*
T2 Yellow/Slow foods										
Step 1. T1 Yellow/Slow	.59***	.13	6.78	1.06	.63	.11	.63	.11	35.25***	2.50+
Age	.36***	.23+	4.02	1.81	–	–	–	–	–	–
BMI-Z score	–.04	–.05	–.511	–.400	–	–	–	–	–	–
Step 2. Intervention (HIP)	–.08	.24*	–.943	1.85	.64	.16	.01	.05	.889	3.42+
T2 Red/Whoa foods										
Step 1. T1 Red/Whoa	.61***	.43***	6.29	4.52	.50	.36	.50	.36	20.63***	11.44***
Age	.20+	.15	1.95	1.49	–	–	–	–	–	–
BMI-Z score	.08	.16	.808	1.67	–	–	–	–	–	–
Step 2. Intervention (HIP)	–.045	.39***	–.460	3.87	.50	.49	.00	.13	.211	14.94***
T2 Overall Score										
Step 1. T1 Overall Score	.73***	.48***	9.85	5.24	.72	.44	.72	.44	52.83***	15.97***
Age	.20*	.150	2.52	1.59	–	–	–	–	–	–
BMI-Z score	.00	.18*	.001	2.01	–	–	–	–	–	–
Step 2. Intervention (HIP)	.10	.35***	1.39	3.74	.73	.55	.01	.11	1.93	13.98***

Note: Intervention variable was dummy coded; HIP – Healthy-Lifestyle Intervention Program (coded as 1) was compared to non-nutritional summer group (coded as 0).
***p < .001, **p < .01, *p < .05, + p < .10.
Part A = expressive knowledge, Part B = health classification; T1 = pre-intervention, T2 = post-intervention.

(STP-PreK). Of note, no baseline differences between the groups were noted during the first administration of the DIANA (completed prior to the start of HIP).

Finally, as seen in Table 4, regression analyses, controlling for age and BMI-z score given the earlier documented differences in children from HIP vs. STP-PreK as well as associations between age and baseline scores, indicated that compared to children in the STP-PreK, children in HIP experienced significantly greater improvements in their overall health classification score (Part B β = .35, $p < .001$) as well as the Part B (health classification) subscales (Green/Go, Yellow/Slow, and Red/Whoa; β range: .24–.39, $p < .05$). Children in HIP versus STP-PreK also showed greater improvements on Part A (expressive knowledge) of the Green/Go subscale (β = .22, $p < .01$). No significant differences on Part A (expressive knowledge) of the Yellow/Slow and Red/Whoa subscales or overall Part A score were found.

Discussion

Increasing children and adults' nutritional knowledge and/or awareness is a major focus of not only behavioral family-based interventions targeting pediatric obesity (Epstein et al., 2007), but also community and school-wide prevention and interventions programs that promote healthier lifestyles (Khambalia et al., 2012; Larson et al., 2011; Story et al., 2006). Despite such efforts, instruments to assess nutritional knowledge have mostly focused on older children in late elementary or middle school (Fahlman et al., 2008; Lee et al., 2009), adolescents (Turconi et al., 2003), or adults (Parmenter & Wardle, 1999). Very few studies with young preschool age children have measured nutritional knowledge, with most of them utilizing a dichotomous system of healthy vs. unhealthy distinction (Başkale & Bahar, 2011; Sigman-Grant et al., 2014). The current study was the first, to our knowledge, to attempt to measure nutritional awareness in preschoolers using the entire range of the Stop-Light Diet System. Developing a reliable instrument to measure nutritional awareness in young children was particularly important given the high rates of pediatric obesity within preschoolers (de Onis, Blossner, & Borghi, 2010) as well as recent efforts to provide day care wide interventions (Larson et al., 2011; Story et al., 2006).

Consistent with the few nutritional awareness measures used with young children (Başkale & Bahar, 2011; Sigman-Grant et al., 2014), the DIANA was designed to be developmentally appropriate (i.e., use of pictures, interview format vs. questionnaire) and target two basic aspects of nutritional knowledge/awareness: a) children's ability to recognize and name a wide range of foods and b) children's ability to classify foods according to their relative healthiness. The psychometric results of the current study provided evidence for such construct validity as both Part A (*expressive knowledge*) and Part B (*health classification*) showed good internal consistency and test–retest reliability. Additionally, children obtained a higher proportion of items correctly in Part A versus Part B suggesting better basic knowledge of types of foods but not necessarily their health content. In fact, unhealthy Red/Whoa foods were more readily recognized and named by children yet not recognized as unhealthy during the classification part. Such disconnect found in the current study is not surprising given that advertisement promoting fast food and sugary drinks target children directly and affects their preferences and requests for such unhealthy products (Harris, Sarda, Schwartz, & Brownell, 2013).

Of note, Part B of the Yellow/Slow subscale was the only subscale to show poor test–retest reliability perhaps highlighting young children's difficulty in understanding that certain foods are not simply "good" or "bad" for you but require moderation. However, young children who participated in the healthy-lifestyle intervention (HIP) group did improve their ability to classify such Yellow/Slow foods (along with Green/Go and Red/Whoa foods) compared to children who did not receive any nutrition based intervention. It is important to note that while the HIP curriculum was not solely designed to teach children how to classify certain foods (no special emphasis on any foods depicted in the DIANA), it is likely that children may have been partially exposed to some of the items on the DIANA during the camp. Hence, children's improved Yellow/Slow scores may positively reflect how well they learned the health curriculum during camp. These preliminary findings suggest that although young children without training/health education tend to have a more dichotomous view of foods as healthy or unhealthy, they do seem cognitively capable of learning (e.g., via a health intervention) that certain foods may fall into a moderately healthy category.

There were some limitations to the current study that need to be addressed. First, while the overall scores in Part A (expressive knowledge) and Part B (health classification) demonstrated good to excellent internal consistency and test–retest reliability, the proposed subscales that mapped to the Stop-Light system (i.e., Green/Go, Yellow/Slow, and Red/Whoa) showed weaker, yet for the most part acceptable, psychometric properties. This is particularly relevant for the Yellow/Slow subscale which showed the weakest test–retest reliability. Given the overrepresentation of Green/Go foods in the DIANA, it will be important for future iterations of the DIANA to investigate whether adding more Yellow/Slow and Red/Whoa items would improve each subscale's psychometric properties. Additionally, it is important to note the uneven and small sample size of children in the HIP group which was used to measure the DIANA's divergent validity. It will be important for future studies with larger samples to conduct a factor analysis to confirm the structure of the proposed subscales as well as its divergent validity. Second, given that Part A of the DIANA required children to name the food, this scale may not be appropriate for use with children displaying language delays. It would be important to determine whether a multiple choice type of format where children would point to the picture of a spoken food item (rather than having to provide a verbal response) would yield similar or better psychometric properties. A third limitation was the homogeneity of the sample, which was largely Latino (86%) due to the study's geographical location. However, this limitation may also be viewed as a strength as Latino children represent the fastest growing group in the U.S. but are typically underrepresented across scientific studies including pediatric psychology (Clay, Mordhorst, & Lehn, 2002; Sue, 1999). Nevertheless, future research should investigate the psychometric properties of the DIANA among other ethnic groups. A final limitation was the inability to collect food log data from parents on children's eating behaviors which would have provided information on whether the changes observed in children's nutritional awareness related to actual changes in parents' implementation of the nutritional curriculum.

In sum, our findings highlight the promise of the DIANA as a developmentally appropriate way to measure young children's nutritional knowledge/awareness, with strong psychometric results found for Part A (expressive knowledge regarding various foods) but more mixed results for Part B (perception of each food's health according to the Stop-Light System). Specifically, the Yellow/Slow subscale had poor test–retest reliability suggesting that young children, without training/health education, tend to have a more dichotomous view of foods as healthy or unhealthy as some past studies have documented (Başkale & Bahar, 2011; Sigman-Grant et al., 2014). On the other hand, preliminary data from a small pilot sample suggest that the DIANA, including the Yellow/Slow subscale, is sensitive to intervention effects by discriminating scores between children who participated in a healthy-lifestyle intervention (HIP) and those who did not. While confirmation with a larger sample is needed, the current study is the first to show that young children may be cognitively capable of learning (e.g., via a health intervention) that certain foods may fall into a moderately healthy category (i.e., Yellow/Slow). Lastly, future investigations should investigate whether children's performance on the DIANA serves as a proxy for parents' nutritional knowledge and overall healthy lifestyle.

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