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Article *in* Asia Pacific Journal of Clinical Nutrition · January 2018

DOI: 10.6133/apjcn.201811_27(6).0018

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Original Article

Weight status and food habits of preschool children in Abu Dhabi, United Arab Emirates: NOPLAS project

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Background and Objectives: Eating habits established during childhood affect health in later life. The United Arab Emirates (UAE) has a high prevalence of obesity in adolescents and adults; however, data on the health of preschool children are scarce. This study assessed the weight status and dietary habits of Emirati and non-Emirati children attending nurseries in Abu Dhabi, UAE. **Methods and Study Design:** Weight and height were measured in children aged 18 months–4 years. Z scores for height-for-age (HAZ), weight-for-age (WAZ), and BMI-for-age (BAZ) were calculated based on WHO protocols. Parents completed a questionnaire regarding demographics and food frequency. **Results:** A total of 203 children participated. Abnormal anthropometric status (z scores of <-2 or >2) for WAZ was indicated in 12.8% of Emirati children versus 1.4% of non-Emirati children ($p=0.008$) and for BAZ in 19.9% of Emirati children versus 8.4% of non-Emirati children ($p<0.05$). Emirati children exhibited higher prevalences of malnutrition (4.3% vs 1.4%), wasting (11.5% vs 2.8%), and overweight (8.5% vs 4.2%) than non-Emirati children and consumed discretionary calorie foods and typical components of Emirati cuisine (rice, fish, and pulses) significantly more often than non-Emirati children. **Conclusions:** Similar to findings in other countries undergoing economic transition, an indication of a double burden of disease was revealed in children attending nurseries in Abu Dhabi. Malnutrition and overnutrition were represented, especially among Emirati children, and were seemingly related to lifestyle rather than genetics. Therefore, policies focusing on child health interventions are required.

Key Words: nutrition, dietary habits, United Arab Emirates, preschool children

INTRODUCTION

The preschool age is a critical stage that influences a child's physical and cognitive health and development. Inadequate feeding and suboptimal growth in the early years of life may lead to growth failure, malnutrition, and compromised academic performance in addition to an increased risk of developing non communicable diseases later in life.[1-5] Similarly, overnutrition is associated with increased risks of chronic diseases. Obese children are more likely to become obese adults and have a higher risk of developing metabolic syndrome, cardiovascular diseases, and diabetes as adults.[6-9]

The United Arab Emirates (UAE) has undergone considerable cultural and economic development over the preceding few decades, resulting in marked shifts in lifestyle and a notable nutritional transition among its citizens.[10] In addition, the country's economic growth has contributed to the creation of a multinational society, with 80.7% of the population being expatriates from other countries, and this has increased the variety of food options.[11] Studies conducted in the Middle East have demonstrated that preschoolers exhibit suboptimal health and food intake, with deficiencies and overnutrition being reported.[12-16] A recent study conducted in Saudi Arabia revealed that many preschoolers were stunted and underweight. In Egypt, underweight and wasting were observed.[16] In Qatar, a country with a similar food culture to that of the UAE, 9.5% of children below 5 years of age were vitamin D deficient and in Egypt, 27.2% from the same age group were anaemic.[17] In the Middle East, a high intake of discretionary calories and low intake of micronutrients have been reported; however, these studies are dated and few recent studies have investigated nutrition among preschoolers. In the UAE, the prevalence of overweight and obesity among school-aged children is 34%, with 18.9% of children being reported as obese. This suggests that the UAE has one of the highest national rates of childhood obesity worldwide.[18,19] Nutrition-related noncommunicable diseases such as hypertension and type 2 diabetes have also been reported in this age group. The prevalences of 6–19 year olds with prehypertension and hypertension are approximately 10% and 14%, respectively.[20] Moreover, the prevalences of prediabetes and type 2 diabetes among overweight and obese 11–17-year-old children are 5.4% and 0.87%, respectively.[21] Furthermore, 7.6% of Emirati school children are

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Manuscript received 21 March 2018. Initial review completed 29 March 2018. Revision accepted 07 May 2018.
doi: 10.6133/apjcn.201811_27(6).0018

underweight, reflecting a complex health situation among school children in the UAE, similar to other countries undergoing periods of economic transition.[19,22]

The association between health and socioeconomic status (SES) is well established. Developed countries demonstrate strong inverse associations between SES and unhealthy eating patterns, increased screen time, and reduced physical activity, suggesting that children of parents of lower SES may be at a higher risk of developing poor health.[23-25] Conversely, findings from developing countries undergoing economic transition indicated a higher prevalence of obesity in children of parents in high income brackets.[26] In China, preschool children from urban areas and higher income households experienced their highest increase in obesity prevalence from 2009 to 2011.[27] However, in the UAE, the association between SES and the health of preschool children is yet to be explored.[19]

Given the magnitude of the health problems among children and adults in the UAE, identifying health-depriving and health-promoting patterns at a young age is crucial. Few data on preschool children's health are available. Previous studies of older age groups have emphasised the requirement for research on toddlers and preschoolers to bridge this knowledge gap.[19] Studying these age groups is critical for the development and implementation of effective health policies and strategies throughout the life cycle in alignment with the vision of the UAE government to improve the population's health and reduce health care costs.[28]

The conceptual framework for the hypothesis that guided this study is presented in Figure 1. This study investigated dietary habits and weight status in Emirati and non-Emirati preschoolers attending nurseries in Abu Dhabi, UAE and examined the demographic and socioeconomic determinants.

METHODS

Population

The Abu Dhabi Emirate, one of seven emirates (states) in the UAE, consists of three regions, the Abu Dhabi capital district being the largest in terms of area and population density.[29] In 2015, 40,505 (19,780 girls and 20,725 boys) children aged 0–4 years were residing in the capital district of Abu Dhabi.[11] The preschool educational system in the UAE is noncompulsory and consists of nurseries that enrol children of up to 4 years of age.[30] Overall, in 2015, 11,756 children were enrolled in 129 nurseries listed by the Ministry of Social Affairs, the regulatory body for nurseries. This study is part of a project titled the Nutrition, Oral health, Physical development, Lifestyle, Anthropometry, and Socioeconomic status (NOPLAS), in which the target population was nursery children aged 18 months–4 years residing in the capital district of Abu Dhabi.

Design

This cross-sectional study employed a stratified random sampling design where clusters consisted of nurseries stratified geographically into urban, suburban, and rural strata. A schematic diagram of the overall study design is provided in Figure 2. In 2015–2016, parents of children were recruited during drop-off or pick-up times at preschools through face-to-face interaction with the researchers. Parents received oral and written information about the study and were encouraged to ask questions before deciding whether to participate. Consenting parents were asked to complete a structured questionnaire available in English and Arabic. Moreover, the children underwent an anthropometric assessment.

Questionnaire

Data were collected in relation to general health (e.g., health conditions, medications, stool, nutrient supplementation) and socioeconomic background (nationality, education, self-rated financial status). The questionnaire also analysed dietary habits determined through an FFQ consisting of 42 items covering all food groups and discretionary calorie food items. The FFQ was derived from a validated FFQ and was adjusted specifically for UAE

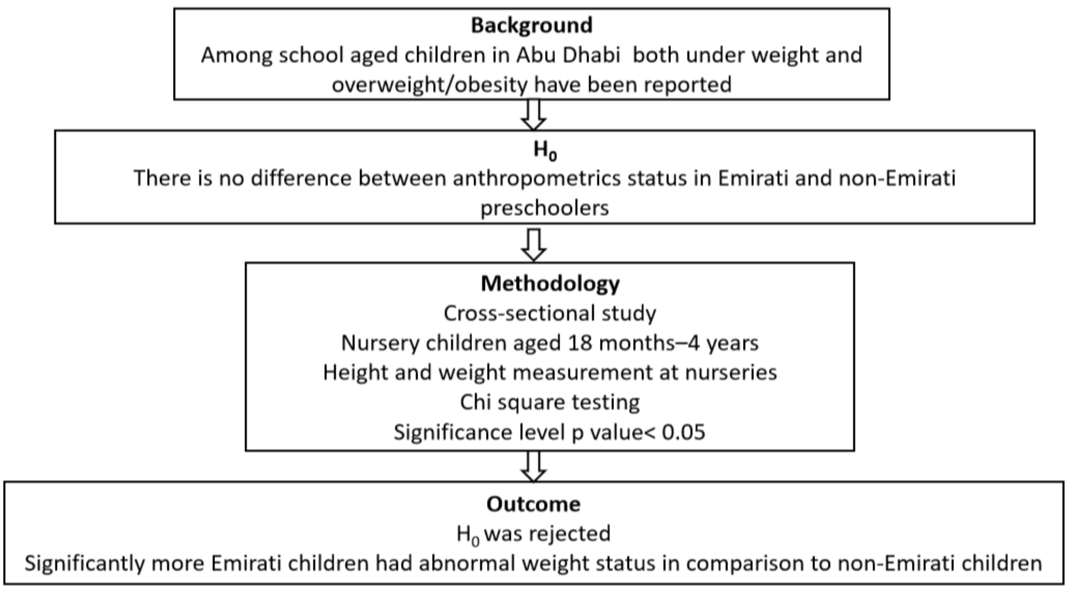

Figure 1. Conceptual framework for the study hypothesis.

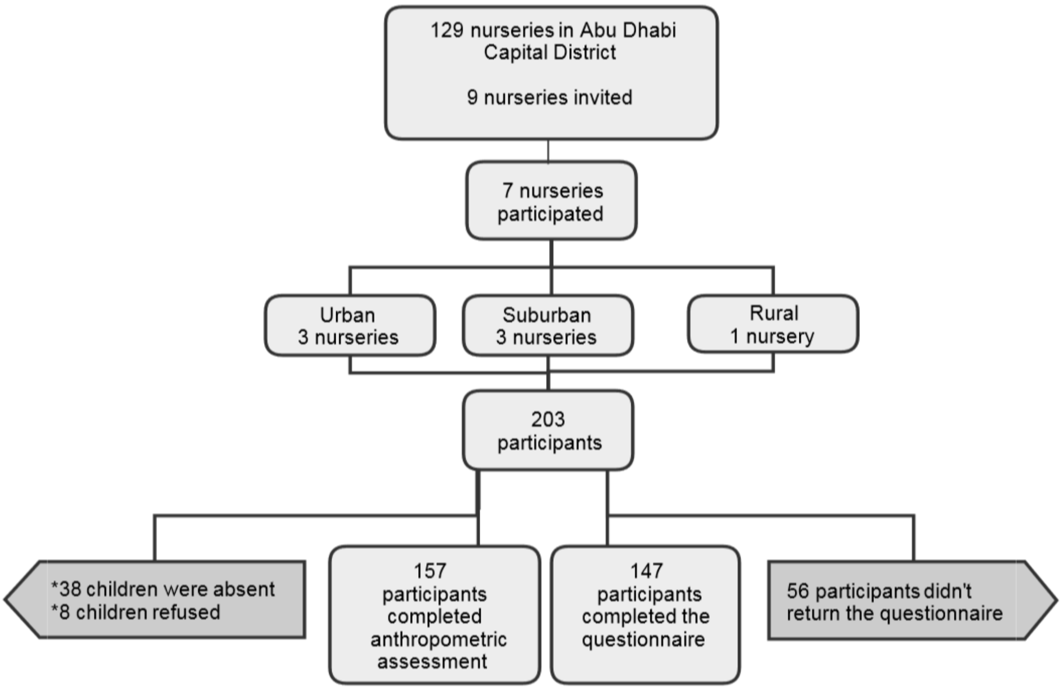

Figure 2. Schematic diagram of the overall study design targeting nursery children (aged 18 months–4 years) in Abu Dhabi, UAE.

culture. The FFQ contained five response choices: 'more than 1 time/day', '6–7 times/week', '3–5 times/week', '1–2 times/week', and 'fewer than 1 time/week or never'.

Anthropometric measures

The children received anthropometric assessments while wearing light clothing at the nurseries. Their heights (cm) and weights (kg) were measured to the nearest tenth decimal with a calibrated Adam MDW 250 L digital medical scale (Adam Equipment, USA). To minimise each child's anxiety, the assessments were conducted in a playful manner by the study investigators and attended by a nursery teacher or nurse familiar to the children.

Ethical considerations

This study was approved by the Research Ethics Committee at Zayed University, UAE (ZU15_029_F), and complied with the Declaration of Helsinki Ethical Principles for Medical Research. This study was conducted in agreement with the Ministry of Social Affairs, Abu Dhabi. Approval was obtained from the nursery management to conduct the project within the nursery premises. Study information was provided to parents or legal guardians in English and Arabic and written consent was obtained. Parents had the choice to consent to their child's participation only in part of the study if they did not feel comfortable with all elements of the project. To protect the children's well-being, no child was forced to participate in the anthropometric examination if they were unhappy to do so, regardless of parental approval.

Statistical analyses

WHO growth charts and the WHO Anthro software package (version 3.2.2, January 2011) were used to assess the anthropometric status of the children.[31] BMI was calculated as kg/m^2. Z scores enable comparisons across genders and age groups and are recommended over the use of percentiles. Z scores are calculated as the value of an individual in the sample minus the sample mean divided by the standard deviation (SD). In this study, Z scores were calculated for all participants using the WHO growth standards based on an international sample.[32]

The statistical software package SPSS version 24 was used for all other statistical analyses.[33] Principal component analysis (PCA) was employed to detect dietary patterns in the FFQ responses and was conducted using the factor analysis option in SPSS with the correlation matrix and no rotation of the component solution. The scree plot of the overall variation was examined and the first three components that collectively explained 29.6% of the total variance were further analysed. Component loadings greater than 0.40 were considered to contribute significantly to the pattern. Differences between individual scores on the first three components were analysed in terms of nationality and gender. For statistical purposes, questionnaires with >5 missing food categories were considered invalid and not included in the PCA. Conversely, in those ≤5 missing food categories, food items were categorised as not consumed.

To assess differences in consumption of particular food items the frequency of consumption was weighed as follows: 'fewer than 1 time/week or never' (1/14=0.07), '1–2 times/week' (1.5/7=0.21), '3–5 times/week' (3.5/7=0.5), '6–7 times/week' (1), 'more than 1 time/day' (1.5). This weighting was used to assess the mean intake of individual food items. Furthermore, it was used to calculate the relative intake of food assessed as indices between particular food items. Food items from the FFQ were categorized into the following groups based on their main nutrient content: grains (e.g. rice, pasta, bread), protein food (e.g. meat, fish, egg), fruits, vegetables, dairy products, sweet-low-nutrient food (e.g. cakes, chocolates) and savory-low-nutrient food (e.g. crisps). Indices were constructed as ratios between particular food items to assess

Table 1. Socioeconomic characteristics of the study population (N=147)

Characteristics	Mother		Father	
	N	%	N	%
Education†				
Primary school	1	0.7	0	0
Middle/high school	29	20.1	19	13.2
Bachelor degree	72	50.0	75	52.1
Higher education	42	29.2	50	34.7
Occupation†				
Stay-home	72	50.0	3	2.1
Self-employed	3	2.1	10	6.9
Part time outside home	13	9.0	13	9.0
Full time outside home	52	36.1	119	82.1
Student	4	2.8	0	0

†Three participants did not provide socioeconomic information.

diet quality, as follows: fruits/protein food, vegetables/protein food, fruits/grains, vegetables/grains, grains/protein food, sweet-low-nutrient food/fruits, sweet-low-nutrient food/vegetables, sweet-low-nutrient food/grains, sweet-low-nutrient food/dairy products, savory-low-nutrient food/fruits, savory-low-nutrient food/vegetables, savory-low-nutrient food/grains and savory-low-nutrient food/dairy products. One-way-ANOVA was performed to assess differences in food intake between the three weight categories (underweight, normal weight, overweight). Statistical significance was set at $p<0.05$.

RESULTS

Sample characteristics

A total of 203 children (42.6% girls) participated in this study. The distribution of participants by nursery location revealed that 35.6% resided in urban areas, 35.1% resided in suburban areas, and 29.2% resided in rural areas of the Abu Dhabi capital district. The sample included 11.9% 18–24-month-old children, 34.2% 2–3-year-old children, and 53.9% 3–4-year-old children. Almost half of the children (48.2%) were Emiratis. The non-Emiratis were a mixture of Western (e.g., UK, France, Australia, USA), Eastern-Mediterranean (e.g., Egypt, Jordan, Lebanon, Iraq, Syria) and South-East-Asian (e.g., India, Malaysia, Pakistan) children. In total, 72.4% of the sample completed and returned the questionnaire (Figure 2). The loss analysis revealed that considerably more Emirati families than non-Emirati families did not return the questionnaire ($p<0.001$).

Table 1 illustrates the socioeconomic characteristics of the participants. All parents were married. Considerable differences in education level were observed between the different nationality groups; 82.8% of Emirati fathers had a university degree compared with 95.3% of non-Emirati fathers ($p=0.02$), and the corresponding percentages for mothers were 73.8% and 92.2%, respectively ($p=0.006$). No families considered themselves poor; 2.2%, 63.3%, 33.1%, and 1.4% rated their economic statuses as lower-middle income, middle income, upper-middle income, and wealthy, respectively.

General health

Most parents (92.5%) reported their children to be healthy, whereas 11 children had chronic health conditions, including 7 children with asthma or allergies and 1 each with Glucose-6-Phosphate Dehydrogenase Deficiency (G6PD), stable kidney condition, and thalassemia minor and 1 who had undergone cardiovascular surgery. Approximately one quarter of the children (28.6%) took vitamins or mineral supplements. Birth data revealed that 82.9% of the children were born ≥38 weeks after conception (on term) and 7.1% were born <38 weeks after conception. The mean (SD) birthweight in the studied sample was 3.16 (0.67) kg; however, many parents did not recall their children's birth heights. Most children (86.9%) had been breastfed, with no differences reported between nationalities. A majority of the children passed stool daily but constipation was reported among 14.3% of the non-Emirati children and 5.4% of the Emirati children. In addition, 16% of the children had experienced pain associated with defecation. Considerably more non-Emirati children had solid stool than Emirati children, who tended to have semisolid stool ($p<0.001$), whereas no differences were observed in relation to diarrhoea.

Anthropometric status

While all parents consented to their children being assessed for weight and height, not all children did, with 3.9% refusing to participate in the measurements. Each nursery was visited at least three times for measurements, but because of absences, 77.3% of the children underwent anthropometric assessment (Figure 2). Table 2 reveals the mean Z scores, height, weight, and BMI by age. A significant difference between gender was indicated in the heights of children aged >36 months, with boys being considerably taller (100.7 cm, SD=5.8) than girls (98.2 cm, SD=5.5) ($p<0.05$).

In the Z score analysis, differences were observed between nationalities but not the sexes. Table 3 displays the Z scores for children based on nationality. The majority of the children exhibited normal growth. A considerably higher percentage of non-Emirati children than Emirati children were within the normal distribution (Z score of -2 to 2) of the weight-for-age Z score (WAZ; 98.6% vs 87.2%, respectively, $p=0.008$); 80% of the Emirati children were within the normal distribution of the weight-for-height Z score (WHZ) compared with 91.6% of the non-Emirati children ($p<0.05$), and 80.1% of the Emirati children were within the normal distribution of the BMI Z score (BAZ) compared with 91.6% of the non-Emirati

Table 2. Z scores and height, body weight, and BMI by age (N=157)

Category	Mean (SD)
Height (cm)	
<24 months	82.8 (5.1)
25-36 months	92.6 (4.8)
>36 months	99.7 (5.8)
HAZ	0.03 (1.39)
Body weight (kg)	
<24 months	12.4 (2.1)
25-36 months	13.9 (2.0)
>36 months	15.5 (2.3)
WAZ	0.14 (1.14)
BMI (kg/m^2)	
<24 months	17.9 (1.9)
25-36 months	16.2 (1.6)
>36 months	15.5 (1.8)
BAZ	0.20 (1.40)

HAZ: length or height-for-age Z score; WAZ: weight-for-age Z score; BAZ: BMI-for-age Z score.

children (p<0.05). As significant differences in anthropometric status was found between the nationality groups, the null hypothesis was rejected. No significant differences were noted in terms of the height-for-age Z score (HAZ) between the two groups. The percentages of children below or above the expected normal growth for the WAZ, HAZ, WHZ, and BAZ are displayed in Figure 3. Parents' perceptions of their children's growth indicated that 92.5% of parents believed that their child's growth was normal, compared with 2.0% and 5.5% for fast growth or difficulties in growth, respectively.

Eating habits

Most children consumed three main meals daily, with 91% eating breakfast, 90.3% eating lunch, and 85.7% eating dinner, and no significant differences observed between nationalities or the sexes. Snacks were consumed at least once daily by 74.7% of the children. Table 4 reveals the frequency of consumption of various food items by nationality. Few children were still breastfeeding but approximately one-third of the children drank formula milk daily. Although no differences were noted in terms of the consumption of cookies and biscuits between the two nationality-based groups, the Emirati children consumed other food items high in sugar and/or fat such as flavoured milk, muffins, Nutella, soft drinks, fruit syrups, chocolates, and candy significantly more frequently than did the non-Emirati children. Consumption of diet soft drinks was restricted to the Emirati children, who also consumed juice significantly more frequently than did the non-Emirati children. Fresh fruit, a source of vitamin C and fibre was consumed daily by most children in both groups; however, a small proportion of children consumed fruit less than once per week (Table 4). Fewer children consumed vegetables daily, with white vegetables being the least consumed.

The Emirati food culture was reflected in the children's food habits; the Emirati children consumed rice, fish, eggs, and pulses significantly more frequently than did the non-Emirati children; however, no differences were reported in terms of bread consumption, which is also considered a staple in Emirati food culture.

PCA

The first three components accounted for 29.6% of the total variation in food frequency responses. Table 5 describes the component coefficients for the first three principle components based on the FFQ. The first component (PC1) was highly loaded with high-calorie-low-nutrient foods including chocolate, candy, soft drinks, cakes, biscuits, and chips. Other foods with high loadings on this component included fish, rice, and pulses. Component 2 (PC2) had high loadings for vegetables, dried fruits, and pulses that are rich in vitamin C and dietary fibre. Component 3 (PC3) had high loadings for rice and sandwich ingredients such as processed meats, cream cheese, butter, and margarine which are sources of either protein, fat or both. Scores on the first three components were analysed based on nationality and sex. No differences were noted between the sexes for any component. When analysed based on nationality, highly significant differences between the mean scores for PC1 and PC3 (both p<0.001) but not for PC2 were observed. Figure 4 displays PC1 and PC3 component scores based on the FFQ plotted based on nationality (Emirati and non-Emirati children). The Emirati children tended to score lower on PC1 and have a lower mean score, indicating that they consumed foods with high positive component loadings more frequently

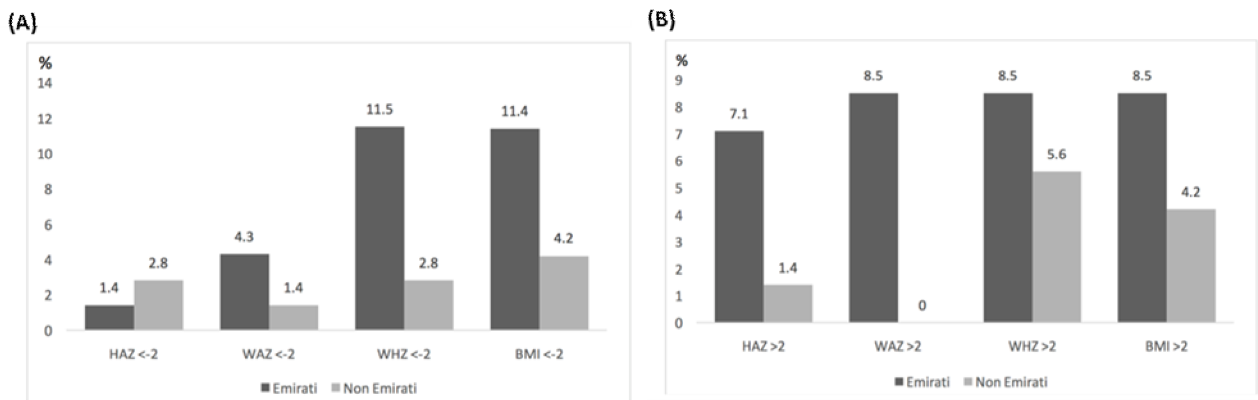

Figure 3. Percentages of Emirati and non-Emirati nursery children (a) below or (b) above expected normal growth based on the WAZ, HAZ, WHZ, and BAZ. N=142.

Table 3. Anthropometric Z scores for children aged 18 months–4 years attending nurseries in Abu Dhabi (N=157)

	Total	Z-score <-3		Z-score -3-to -2		Z-score -2 to -1		Z-score -1 to 1		Z-score 1-2		Z-score 2-3		Z-score >3	
Variable	n	N	%	n	%	n	%	n	%	n	%	n	%	n	%
All children															
HAZ	157	2‡‡	1.3	3	1.9	33	21.0	78	49.7	32	20.4	3	1.9	6	3.8
WAZ	157	0	0.0	5‡	3.2	21	13.4	97	61.8	27	17.2	6	3.8	1	0.6
WHZ	157	2	1.3	8	5.1	16	10.2	96	61.1	24	15.3	10	6.4	1	0.6
BAZ	157	3	1.9	8	5.1	18	11.5	91	58.0	27	17.2	7	4.5	3	1.9
Emirati†															
HAZ	70	0	0.0	1	1.4	17	24.3	37	52.9	10	14.3	1	1.4	4	5.7
WAZ	70	0	0.0	3	4.3	14	20.0	44	62.9	3	4.3	5	7.1	1	1.4
WHZ	70	2	2.9	6	8.6	8	11.4	43	61.4	5	7.1	5	7.1	1	1.4
BAZ	70	3	4.3	5	7.1	11	15.7	37	52.9	8	11.4	5	7.1	1	1.4
Non-Emirati															
HAZ	72	2	2.8	0	0.0	13	18.1	36	50.0	19	26.4	1	1.4	1	1.4
WAZ	72	0	0.0	1	1.4	5	6.9	48	66.7	18	25.0	0	0.0	0	0.0
WHZ	72	0	0.0	2	2.8	7	9.7	44	61.1	15	20.8	4	5.6	0	0.0
BAZ	72	0	0.0	3	4.2	6	8.3	45	62.5	15	20.8	2	2.8	1	1.4

HAZ: length or height-for-age Z score; WAZ: weight-for-age Z score; WHZ: Weight-for-height Z score; BAZ: BMI-for-age Z score.
†Fifteen children did not report their nationalities.
‡Including one child with a stable kidney condition.

Table 4. Percentages of Emirati and non-Emirati nursery children (aged 18 months–4 years) and consumption of various food items based on the FFQ results (N=147)

Food category	Emirati children (n=58)†			Non-Emirati children (n=89)†			*p*-value (χ^2 df)	Significance level
	>6 times/w (%)	1-5 times/w (%)	<1 time/w (%)	>6 times/w (%)	1-5 times/w (%)	<1 time/w (%)		
Full fat milk/Yoghurt/Laban	78.6	19.6	1.8	78.2	6.9	14.9	0.005	**
Low fat milk/Yoghurt/Laban	12.5	18.8	68.8	19.2	20.5	60.3	0.551	
Flavoured milk	31.6	42.1	26.3	14.3	21.4	64.3	<0.0001	***
Breastmilk	2.3	0.0	97.7	5.1	0.0	94.9	0.415	
Formula milk	40.9	9.1	50.0	39.5	2.5	58.0	0.229	
Hard cheese	22.6	50.9	26.4	18.6	54.7	26.7	0.839	
Cream cheese/Labnah	35.7	50.0	14.3	15.5	51.2	33.3	0.005	**
Feta cheese/Halloumi or similar	4.1	38.8	57.1	6.0	31.0	63.1	0.642	
Muffins/Donuts or similar	25.9	65.5	8.6	9.3	43.0	47.7	<0.0001	***

†Individual food items may have some missing data.
*$p<0.05$; **$p<0.01$; ***$p<0.001$.

Table 4. Percentages of Emirati and non-Emirati nursery children (aged 18 months–4 years) and consumption of various food items based on the FFQ results (N=147) (cont.)

Food category	Emirati children (n=58)[†]			Non-Emirati children (n=89)[†]			*p*-value (χ^2 df)	Significance level
	>6 times/w (%)	1-5 times/w (%)	<1 time/w (%)	>6 times/w (%)	1-5 times/w (%)	<1 time/w (%)		
Savoury croissants or pastries	8.9	53.6	37.5	4.8	29.8	65.5	0.005	**
Bread (not sweet)	53.6	44.6	1.8	44.0	48.8	7.1	0.261	
Biscuits/cookies and similar	25.9	58.6	15.5	19.8	54.7	25.6	0.316	
Porridge	14.5	49.1	36.4	29.8	36.9	33.3	0.105	
Meat (whole pieces)	15.5	67.2	17.2	19.3	64.8	15.9	0.838	
Bacon/Sausages/Hotdogs	0.0	33.3	67.7	2.4	29.4	68.2	0.485	
Minced meat/Kebabs	4.1	46.9	49.0	3.5	58.1	38.4	0.453	
Fatty fish	12.3	68.4	19.3	3.5	55.8	40.7	0.008	**
Lean fish	13.2	66.0	20.8	3.4	48.9	47.7	0.002	**
Lentils/Dried beans/Chickpeas/Hummus	20.0	52.7	27.3	4.5	55.7	39.8	0.010	*
Eggs/Omelettes/Scrambled eggs	38.6	56.1	5.3	23.9	55.7	20.5	0.018	*
Yellow/Orange/Red vegetables	37.5	55.4	7.1	44.8	49.4	5.7	0.679	
Green vegetables	22.8	61.4	15.8	38.2	49.4	12.4	0.151	
White vegetables	30.9	52.7	16.4	21.3	64.0	14.6	0.360	
Fresh fruits/Fruit salad	69.0	27.6	3.4	84.3	12.4	3.4	0.064	
Dried fruits	14.5	34.5	50.9	26.4	46.0	27.6	0.016	*
Juices	67.3	29.1	3.6	36.8	46.0	17.2	0.001	**
Rice	92.7	7.3	0.0	25.3	63.2	11.5	<0.0001	***
Pasta/spaghetti	50.0	48.1	1.9	18.4	66.7	14.9	<0.0001	***
Other grains e.g. quinoa, bulgur, barley	9.1	20.0	70.9	2.5	30.9	66.7	0.114	
Nutella/Peanut butter	14.3	46.4	39.3	5.9	23.5	70.6	0.001	**
Crisps/Snack mixes/French fries	19.6	39.3	41.1	1.2	37.2	61.6	<0.0001	***
Nuts/Almonds	21.4	53.6	25.0	14.1	38.8	47.1	0.030	*
Butter/Margarine for sandwiches	19.6	25.0	55.4	15.1	37.2	47.7	0.306	
Mayonnaise	5.7	18.9	75.5	0.0	17.3	82.7	0.089	
Deli meat	1.9	11.3	86.8	2.4	30.1	67.5	0.036	*
Whipped cream/ Full fat Labnah	5.3	43.9	50.9	4.8	24.1	71.1	0.043	*
Low fat cream/ Low fat Labnah	0.0	14.3	85.7	0.0	12.2	87.8	0.720	
Syrups/Fruit punches/Fruit squash	10.5	28.1	61.4	2.4	8.3	89.3	0.000	***
Soft drinks	3.7	25.9	70.4	1.2	7.1	91.7	0.005	**
Soft drinks light	3.7	16.7	79.6	0.0	1.2	98.8	0.001	**
Ice cream	7.1	48.2	44.6	1.1	49.4	49.4	0.159	
Chocolates	33.9	51.8	14.3	1.2	62.8	36.0	<0.0001	***
Candy/Sweets (not chocolates)	23.2	51.8	25.0	4.7	32.6	62.8	<0.0001	***

[†]Individual food items may have some missing data.
[*]$p<0.05$; [**]$p<0.01$; [***]$p<0.001$.

Table 5. Component coefficients for the first three principal components. Food categories are sorted by the first principal component loadings (N=147)

Food category	Principal component coefficients		
	Component 1	Component 2	Component 3
Percentage of total variance	15.17%	7.78%	6.62%
Candy/Sweets (not chocolates)	0.755†	-0.091	-0.058
Chocolates	0.686†	-0.192	-0.151
Muffins/Donuts or similar	0.656†	-0.112	-0.077
Soft drinks light	0.618†	-0.154	0.231
Savoury croissants or pastries	0.578†	0.181	0
Nutella/peanut butter	0.570†	-0.09	0.204
Soft drinks	0.536†	-0.257	0.27
Flavoured milk	0.514†	0.049	-0.315
Crisps/Snack mixes/French fries	0.506†	-0.342	-0.117
Rice	0.503†	0.148	-0.419†
Ice cream	0.467†	-0.156	0.273
Lentils/Dried beans/Chickpeas/Hummus	0.466†	0.422†	0.217
Biscuits/Cookies/Crackers/Arabic sweets	0.456†	-0.122	0.054
Pasta/spaghetti	0.454†	0.168	-0.008
Fatty fish (salmon, tuna, mackerel, sardines)	0.446†	0.392	-0.09
Juices	0.438†	-0.274	-0.272
Whipped cream/Full fat Labnah	0.434†	-0.031	-0.197
Mayonnaise	0.417†	-0.132	0.333
Lean fish	0.413†	0.393	-0.241
Syrups/Fruit punches/Fruit squash	0.411†	-0.293	0.268
Eggs/Omelettes/Scrambled eggs	0.381	0.39	-0.299
Cream cheese/Labnah	0.360	0.174	-0.444†
Nuts/Almonds	0.352	0.257	-0.105
Bacon/Sausages/Hotdogs	0.311	-0.204	0.514†
Full fat milk/Yoghurt/Laban	0.275	0.188	0.073
Minced meat/Kebabs	0.273	0.224	0.119
Other grains like quinoa, bulgur, barley	0.256	0.281	0.366
Hard cheese	0.228	0.097	0.45
Feta cheese/halloumi/mozzarella	0.222	0.141	0.024
Low fat cream/Low fat Labnah	0.184	-0.023	-0.121
Yellow/orange/red vegetables (like carrots, peppers, corn, tomatoes, pumpkins, sweet potatoes)	0.136	0.642†	0.27
Butter/Margarine for sandwiches	0.133	-0.101	0.426†
Bread (not sweet)	0.131	0.115	-0.146
Meat (whole pieces) Beef/Lamb/Camel	0.061	0.274	-0.024
Porridge (oat, barley, wheat, corn or similar)	0.033	0.294	0.189
Breastmilk	-0.001	0.121	-0.026
White vegetables (onion, cauliflower, potatoes, parsnip or similar)	-0.018	0.642†	0.135
Fresh fruits/fruit salad	-0.098	0.346	-0.031
Deli meat	-0.104	-0.113	0.585†
Formula milk	-0.12	0.089	-0.405†
Low fat milk/Yoghurt/Laban	-0.133	0.15	0.086
Green vegetables (peas, squash, lettuce, zucchini, spinach)	-0.134	0.615†	0.204
Dried fruits (raisins, apricots, dates, figs)	-0.176	0.484†	0.227

†Values with component loadings of at least ç³0.40ç.

than did the non-Emirati children. Almost all children in the overlap zone between the two groups were of Eastern-Mediterranean origin.

Associations between eating habits and weight status

The assessments of the intake of individual food items among children of various weight categories, revealed no considerable differences except for processed meat ($p<0.05$). However, assessing the diet quality measured by different food indices, considerable differences were found between the relative intake of sweet-low-nutrient food/fruits, sweet-low-nutrient food/grains, savory-low-nutrient food/grains and between savory-low-nutrient food/fruits and weight status (Table 6). No considerable differences were found in other tested indices. Moreover, no correlations were found between the PCA component 1 and anthropometrics values, revealing no association between food that are highly loaded with high-calorie-

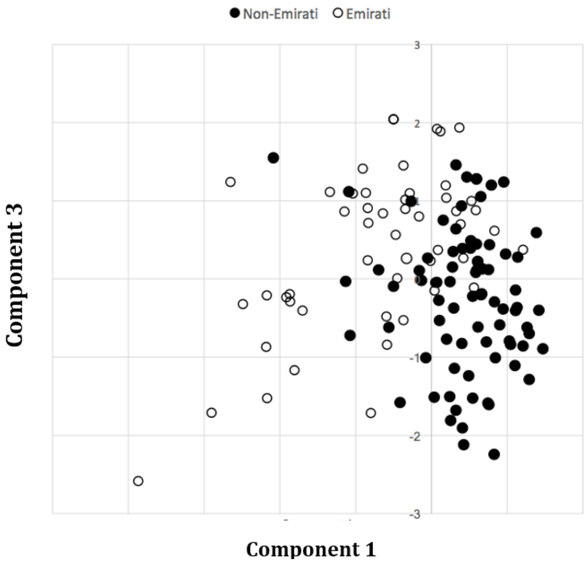

Figure 4. PCA based on the FFQ for nursery children (aged 18 months–4 years) distributed by nationality. PC1 was heavily loaded with high-calorie low-nutrient foods. PC3 had a high loading for rice and sandwich ingredients (delicatessen meat, cream cheese, butter, and margarine); $p<0.001$.

Table 6. The relative consumption of particular food items expressed as indices among children in different weight categories classified based on BAZ (N=124)

Food group indices	Relative consumption of particular food items			One-way-ANOVA *p*-value
	Underweight Mean (SD)	Normal weight Mean (SD)	Overweight Mean (SD)	
Sweet low nutrient food/Fruits				
Chocolate/Fruits	3.81 (8.63)	0.49 (0.81)	0.87 (1.01)	0.001
Biscuits/Fruits	1.60 (2.73)	0.57 (0.69)	0.97 (0.98)	0.018
Cake/Fruits	2.69 (5.68)	0.50 (0.66)	0.62 (0.39)	0.001
Nutella/Fruits	0.78 (1.14)	0.31 (0.64)	2.25 (5.31)	0.003
Candy/Fruits	1.44 (2.80)	0.37 (0.53)	0.53 (0.46)	0.007
Savory carbohydrates/Fruits				
Crisps/fruits	1.26 (2.88)	0.30 (0.41)	0.40 (0.42)	0.01
Sweet low nutrient food/Grains				
Biscuits/Rice	4.17 (5.60)	1.09 (2.16)	0.52 (0.45)	0.008
Biscuits/Pasta	4.09 (5.61)	1.34 (1.93)	1.71 (2.44)	0.018
Cake/Rice	3.25 (5.46)	0.86 (2.08)	0.42 (0.34)	0.043
Chocolate/Rice	4.04 (8.52)	0.70 (0.92)	0.40 (0.41)	0.001
Savory low nutrient food/Grains				
Crisps/Rice	1.57 (2.77)	0.43 (0.57)	0.25 (0.36)	0.004

BAZ: BMI-for-age Z score.

low-nutrient and BAZ, HAZ, WAZ and WHZ.

DISCUSSION

This study was the first to report the weight status and dietary habits of Emirati and non-Emirati nursery children in the Abu Dhabi, UAE. Our findings revealed that significantly more Emirati children than non-Emirati children residing in the UAE were overweight or underweight. Furthermore, the results revealed a distinct overall food consumption pattern among Emirati children compared with children of other nationalities. The Emirati children consumed high sugary foods such as flavoured sweetened milk products, cakes, chocolates, soft drinks, and juice significantly more frequently than did the non-Emirati children from a remarkably young age. The national food culture with its characteristic intake of rice, pulses, fish, and eggs was reflected in the food intake of the Emirati children. Overall, few children consumed the recommended amount of vegetables, whereas a higher percentage of children consumed fruits daily.

Globally, changes related to nutrition and demographic and epidemiological transition are deemed the main causes of the double burden of malnutrition.[34] Epidemiological trends indicated a decrease in undernutrition, whereas overnutrition exhibited an increasing trend.[35] Similar findings have been reported in studies conducted in the UAE.[19,36] However, a substantial number of studies have confirmed the coexistence of under- and over-nutrition in many nations, especially those undergoing nutritional transition.[35,37] In this study, abnormal growth was considerably higher among the Emirati children than the non-Emirati children (p=0.008). The presence of under and overnutrition in this study sample was delineated by 11.5% of the Emirati children exhibiting moderate to severe wasting and 8.5% being overnourished, as revealed by WAZ, HAZ, and BAZ scores of >2.0. These findings are consistent with reports conducted in many parts of the world including Africa, Latin America, and Asia.[26,27,38] Studies published in the Middle East have primarily reported undernutrition among young children. However, excessive weight has been reported in older children. In a recent cross-sectional study conducted in Saudi Arabia including 312 children aged 2–5 years old, wasting, stunting, and underweight were revealed in 6.2%–12.4% of children.[15] In a report from the Ministry of Health in Egypt, 37.5% of preschoolers aged 18 months–5 years were stunted and the prevalences of wasting and underweight varied between 5.7% and 11.3% in the same age group.[16] Notably, the current study observed children below the age of 5 years who were under- or overnourished, suggesting a potential double burden of disease within the preschool age group in the Abu Dhabi. Analyses examining trends of nutritional transition have suggested that countries undergoing the early stages of nutritional transition tend to primarily experience undernutrition. As countries progress economically, abnormal growth in low and middle SES families shifts from undernutrition only, to a double burden of under- and overnutrition and eventually overnutrition will be dominating.[35,37] A report published in the UAE in 1997 revealed findings consistent with this trend and indicated that undernutrition was prevalent in Emirati children.[36] Accordingly, differences related to preschool children's anthropometric status in the UAE and other Middle-Eastern countries might be attributed to the UAE's nutritional transition phase. Egypt and Saudi Arabia can be considered as in the early stages of nutritional transition (i.e., undernutrition is prevalent), whereas the UAE has passed this stage and is undergoing the subsequent stage of a double burden. From a public health perspective, the UAE health authorities are facing the same challenges as many other countries attempting to overcome the double burden of under and overnutrition.

Elsewhere, higher educational attainment has been associated with healthier weight status. In the current sample, parents' education did not significantly contribute to this association. Other recent studies conducted in the UAE have not assessed potential the associations between anthropometric and socioeconomic factors.[19,39] Nationality was revealed to be the only assessed significant factor associated with anthropometrics in the present study, and this supports the findings of previous studies such as Baba et al., who suggested that sociocultural factors may contribute more to this association than economic factors.[36] In the present study, a higher proportion of unhealthy growth among Emirati children was correlated with more children frequently consuming high-energy low-nutrient foods, suggesting that an unhealthy lifestyle rather than a genetic predisposition contributed to these nutritional concerns. Irrespective of nationality, more children were rated as being of normal weight by their parents than revealed by the anthropometric assessments, implying a need for education around healthy child development targeting parents.

Food preferences are developed at an early age. Children who are exposed to healthy food from an early age are more likely to continue to engage in healthy eating habits. A recent study indicated that children with lower self-regulation at the ages of 3 and 5 years gained weight more rapidly and had higher BMI z scores than did other children. In addition, greater self-control and greater ability to delay immediate gratification in preschoolers have been associated with having a lower BMI as an adult.[40] In this study, a high percentage of children had unhealthy eating patterns, exhibiting frequent consumption of discretionary calories from a young age. These results are in agreement with a study conducted in Jordan in 2002, which indicated that nutritional intake was suboptimal among young Jordanian children.[14]

Deficiencies and low intake of iron, calcium, and vitamin D have been reported in other Gulf Cooperation Council countries with similar food cultures to that of the UAE.[12,13,17] In this study a high relative intake of low-nutrient food vs. nutrient rich food was associated with abnormal weight status. Others have reported that a frequent intake of high calorie low-nutrient foods is associated with a lower intake of micronutrients.[41] This may also have implications on the overall health status of preschoolers in terms of increased risk of micronutrient deficiencies, dental caries, and sleep and attention disturbances.

In this study an attempt was made to assess the quality and the diversity of the diet by examining the relative intake of low-nutrient food i.e. sweets, chocolates, crisps versus nutrient-rich food like fruits, vegetables, protein food, grains and dairy products, measured as indices. No significant differences were found in indices of nutrient-rich food groups like grains/protein food between children of various weight categories. However, children with abnormal body composition had a higher relative consumption of low-nutrient foods. Interestingly, the main differences were found between underweight and normal weight children. It may be that parents of underweight children allow their child to consume more sweet or savory low-nutrient foods in attempts to increase their weight. On the other hand, a high supply of unhealthy snacks like chocolate, cakes and crisps may contribute to a lower consumption of nutrient-rich food like grains and fruits, resulting in a negative impact on growth as nutrients are essential for growth and development.[3,41] FFQ is often used as a valid dietary assessment method at food group level, but it does not necessarily provide a reliable assessment of absolute intake of nutrients as portion sizes are not considered, hence these associations should be interpreted with caution.[42-44] Further longitudinal research is imperative to assess the absolute nutrient intake from a young age and its impact on growth.

Child health research conducted in educational settings such as nurseries and schools is considered suitable to access samples representative of a population, thus nurseries were targeted to recruit children.[45] Following the recommendations in published research, efforts were undertaken to maximise the participation rate by receiving the full support of the nursery administration, disseminating electronic and printed invitations, employing bilingual investigators, and engaging in face-to-face contact with parents during regular drop-off and pick-up times and parents' meetings at school.[45] Repeated visits to nurseries was a strategy employed to optimise the participation rate. However, the recruitment of participants posed several challenges, as frequently reported in similar child health studies.[46] The recruitment of parents was effected because many children were brought to nurseries by bus or their nannies-a common practice among all socioeconomic levels in Abu Dhabi. A future strategy to increase parents' active involvement could be to conduct interviews rather than issuing self-administered questionnaires. Regardless, a diverse stratified sample was successfully recruited.

The high socioeconomic level reported in this sample could be explained by the fact that most expatriates recruited to join the workforce in the UAE are highly educated. Another contributing factor could be the cost of nurseries; no statistical data were available regarding income, or the educational levels of Emiratis, making it impossible to evaluate the plausibility of this suggestion. Because the UAE has no mandatory health checks for young children, systematic recruitment of children who do not attend nurseries is difficult. Future studies should consider making household visits to include these children as well.

In the UAE, a country with a mounting burden of lifestyle-related chronic diseases it is imperative to get baseline data. This study is one of the first in the UAE, focusing on food habits and anthropometrics among preschool children, which is a strength as data are scarce in this field. Furthermore, the study was conducted in nurseries, which may have allowed an unbiased representation of this age group. Another strength is that the reflections drawn from the methodology of this study may act as a guidance for other investigators interested in conducting child research in this region. The enrolment of children in the study was hindered by the unexpected “nanny culture” which impacted the ability to recruit more children. The sample size is a limitation that is acknowledged and hence results may not be generalizable. The FFQ was designed for preschool children but it has not been validated in this heterogeneous population. To allow further progress in nutrition research in the UAE future studies should focus on developing dietary assessment tools that have been validated in this population.

To conclude, a possible double burden of disease was revealed in children attending nurseries in Abu Dhabi, UAE, similar to that in other countries undergoing economic transition. Undernutrition and overnutrition were represented, especially among Emirati children. The dietary findings revealed that although most of the children consumed dairy products and fruit daily, most did not meet the international nutritional recommendation for vegetable consumption. The Emirati-specific food culture including regular fish consumption was observed, whereas fewer children from other nationalities ate fish regularly. In addition, the Emirati children consumed high-energy and low-nutrient density foods significantly more frequently than did the non-Emirati children. The findings of the study were primarily related to sociocultural factors rather than educational levels. From a health care perspective, Emirati children seem to be exposed to unhealthier eating behaviours that may negatively affect growth, development, and dental health in the short term and contribute to higher risks of noncommunicable diseases in the long term. The implementation of mandatory health checks from an early age for the early detection of nutritional problems is suggested. Furthermore, child health intervention policies with a focus on health education should be considered to improve health literacy among the UAE population.

ACKNOWLEDGEMENTS
We thank the Ministry of Social Affairs, Abu Dhabi, and the management and staff of the nurseries in this study for supporting the NOPLAS project. Furthermore, we acknowledge the children and parents who participated. We also thank Farah, Nahed, Shajiya, Dhuha, Shaima, and Maitha for their assistance with data entry. Finally, we thank Zayed University for its financial support.

AUTHOR DISCLOSURES
The authors declare no conflicts of interests. This research project (titled NOPLAS: nutrition, oral health, physical development and activity, lifestyle, anthropometry, and socioeconomic status of preschool children in Abu Dhabi) received funding from the Research Incentive Fund (R16055) of Zayed University, UAE. The funding body had no role in the design of the study and collection, analysis, and interpretation of the data and in writing the manuscript.

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