

Glycaemic index and glycaemic load values of commonly consumed foods in the United Arab Emirates

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Abstract

Glycaemic index (GI) and glycaemic load (GL) values of some commonly consumed foods in the United Arab Emirates were determined with an aim of adding these values to the existing international table of GI and GL values. In all, eighteen test foods categorised into breads (*n* 5), entrée dishes (*n* 3), main dishes (*n* 5) and sweet dishes (*n* 5) were tested. For each test food, at least fifteen healthy participants consumed 25 or 50 g available carbohydrate portions of a reference food (glucose), which was tested three times, and a test food after an overnight fast, was tested once, on separate occasions. Capillary blood samples were obtained by finger-prick and blood glucose was measured using clinical chemistry analyser. A fasting blood sample was obtained at baseline and before consumption of test foods. Additional blood samples were obtained at 15, 30, 45, 60, 90 and 120 min after the consumption of each test food. The GI value of each test food was calculated as the percentage of the incremental area under the blood glucose curve (IAUC) for the test food of each participant divided by the average IAUC for the reference food of the same participant. The GI values of tested foods ranged from low (55 or less) to high (70 or more). The GI values of various breads and rice-containing dishes were comparable with previously published values. This study provides GI and GL values of previously untested traditional Emirati foods which could provide a useful guide on dietary recommendations for the Emirati population.

Key words: Glycaemic index: Glycaemic load: Emirati foods: Carbohydrates: Diabetes

The glycaemic index (GI) was introduced in 1981 after observing the dramatic variation in blood glucose response after the ingestion of carbohydrate-rich foods⁽¹⁾. It is defined as 'the incremental area under the blood glucose response curve (IAUC) of a 50 g carbohydrate portion of a tested food expressed as a percent of the response to the same amount of carbohydrate from a reference food taken by the same participant (white bread or glucose), on a different day'⁽²⁾.

Initially, GI was only utilised in the prevention and management of diabetes⁽³⁾. Further, epidemiological and interventional studies investigated other important implications of GI for prevention and treatment of obesity⁽⁴⁾, CVD⁽⁵⁾, CHD⁽⁶⁾ and certain forms of cancer⁽⁷⁾. Recent scientific evidence indicates a possible role of low-GI diets in the treatment and prevention of diabetes mellitus (DM)⁽⁸⁾, obesity⁽⁹⁾, hyperlipidaemia and CVD⁽⁵⁾, by improving insulin sensitivity⁽¹⁰⁾, regulating

appetite⁽¹¹⁾, lowering fasting insulin and C-reactive protein levels⁽¹²⁾, reducing total cholesterol and LDL-cholesterol⁽¹³⁾, and regulating blood pressure⁽¹⁴⁾.

Moreover, the FAO of the UN and the WHO have also validated the use of GI for the classification of carbohydrate-containing foods⁽²⁾, and recommend its use along with food composition tables to guide better food choices. However, several factors like cooking method, food particle size, food processing and starch structure could alter the GI of foods significantly⁽¹⁵⁾. The GI of the same food has been shown to vary in different countries, regions or manufacturers. Emirati traditional foods differ from other cuisines mainly in the ingredients used and the cooking method (e.g. prolonged cooking, mixing all ingredients in one pot), thus it is hypothesised that traditional Emirati foods have different GI values compared with similar foods in the Gulf region.

Abbreviations: GI, glycaemic index; GL, glycaemic load; IAUC, incremental area under the blood glucose response curve.

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The first international table of GI was published in 1995⁽¹⁶⁾ and included 565 separate entries. Updated versions of the GI tables were published in 2002⁽¹⁷⁾ and the most recent in 2008⁽¹⁸⁾. The latter includes the GI and glycaemic load (GL) values of 2487 individual food items⁽¹⁸⁾. However, the majority of the published GI and GL values are from Western countries and not much data are available about the GI values of Arabic foods, particularly Emirati foods. Therefore, the main aim of this study is to provide reliable values of GI and GL of some commonly consumed foods in the United Arab Emirates.

Methods

Participants

A total of eighty-eight healthy participants (thirty-seven males and fifty-one females) from United Arab Emirates University (UAEU), students and staff, were voluntarily recruited to take part in the study. Characteristics of the participants are presented in Table 1. Recruitment was carried out via posters distributed around the university campus and email invitations. All participants were informed about the details of the study, study protocol and were given a chance to ask questions. Informed written consent was obtained from all participants before taking part in the study. Participants were excluded if they were <18 or >40 years; BMI value was ≥ 25 or <18.5 kg/m²; fasting blood glucose value of >6.1 mmol/l or having a known history of impaired glucose tolerance or DM.

Participants were asked to complete a health-screening questionnaire before taking part to confirm that they met the inclusion criteria. Anthropometric measurements were conducted in the Nutrition and Health Department laboratory at UAEU before recruitment to confirm whether a participant met the inclusion criteria. All measurements were obtained at the fasting state (i.e. during active 12-h fast) while wearing minimal clothing (as local culture permits) and no shoes. Height was recorded to the nearest 1 cm using a stadiometer (Seca Ltd) and waist circumference (cm) was measured using a measuring tape. Body weight (kg), fat mass and fat-free mass were measured using Tanita Segmental Body Composition Analyser (TBF-410 MA; Tanita). BMI was calculated as weight (kg) divided by the square of the height (m²).

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures

involving human subjects were approved by the United Arab Emirates University Scientific Research Ethics Committee (ref. no. 516/09).

Test foods

A total of eighteen different foods commonly consumed in the UAE and categorised into breads (*n* 5), entrée dishes (*n* 3), main dishes (*n* 5) and sweet dishes (*n* 5) were tested. The test foods were purchased from popular restaurants in the UAE that specialise in Emirati cuisine and have standardised recipes. Table 2 lists the major ingredients of the test foods.

Analytical methods

Proximate analyses including moisture, protein, fat, fibre and ash content were conducted at the Nutrition and Health Department laboratories of the university following standard methods of the Association of Official Analytical Chemists⁽¹⁹⁾. Total carbohydrate and available carbohydrate content were estimated by difference⁽²⁰⁾. The energy content was calculated by multiplying the amount of protein, carbohydrate and fat by factors of 4, 4 and 9, respectively⁽²¹⁾. Each test was performed in triplicate and the results averaged to minimise possible systematic and random experimental errors.

Study protocol

The procedure for GI measurement was adapted from Wolever *et al.*⁽²²⁾ and Brouns *et al.*⁽¹⁵⁾ and is recommended by Food and Agriculture Organization/World Health Organization⁽²⁾. Testing was repeated in at least fifteen participants for each test food. Prior to the test day, participants were requested to limit their intake of caffeinated drinks and avoid involvement in intense exercise. Participants were asked to fast for 12 h (overnight) the night before each test.

Using the randomised cross-over design, participants tested the reference food three times and each test food for one time only. Food testing was carried out on separate occasions with at least 1-d gap between measurements to minimise any carry-over effects. The reference food provided was glucose powder (glucose dextrose monohydrate) dissolved in 200 ml of water. Test foods were tested in equivalent available carbohydrate amounts (25 or 50 g) as per the reference food and were also served with 200 ml water. Test foods were purchased 1 d before the test, then heated in the morning of the test. Participants were encouraged to consume the reference or test foods within 15 min and to minimise physical activity during the testing time. Available carbohydrate content was used to determine the experimental portion (g) that would provide 50 or 25 g of available carbohydrates from each test food. The majority of test foods were tested against 50 g of available carbohydrate. Nevertheless, if the serving size was found to be too large to ingest comfortably, this test food was tested against 25 g of available carbohydrate⁽¹⁵⁾. In this study, only Chami (cottage cheese) was tested against 25 g of available carbohydrate due to its very low carbohydrate content (5.44/100 g).

Table 1. Anthropometric characteristics of the study population (Mean values and standard deviations for eighty-eight participants, 42 % males to 58 % females)

	Mean	SD
Age (years)	22.1	3.58
Height (m)	1.60	0.05
Weight (kg)	56.89	6.04
BMI (kg/m ²)	22.15	1.89
Waist circumference (cm)	75.06	15.84
Fat mass (%)	28.81	4.64
Fat-free mass (%)	65.79	12.89
Fasting blood glucose (mmol/l)	4.86	0.42

Table 2. Main ingredients of eighteen traditional foods commonly consumed in the United Arab Emirates

Test food	Description	Cooking method	Major ingredients
Breads			
Arabic bread	Baked bread	Baked in a masonry oven	Refined wheat flour, salt, yeast and water
Regag bread	Thin crispy crepe	Baked in a pan	Refined wheat flour, salt and water
Chebab bread	Emirati pancake	Baked on a crepe oven	Whole-wheat flour, egg, yeast, salt, sugar, milk powder, saffron and water
Muhalla bread	Emirati sweet crepe	Baked on a crepe oven	Refined wheat flour, egg, sugar, milk powder, saffron, cardamom and water
Khameer bread	Baked bread	Baked in a masonry oven	Whole-wheat flour, egg, yeast, salt, sugar, milk powder, saffron and water
Entrée dishes			
Fendal	Boiled sweet potato	Boiled, whole, unpeeled	Beauregard sweet potato and water (dates added to the boiling water as a sweetener)
Chami	Cottage cheese	Cooked buttermilk	Buttermilk, salt and white cumin seeds
Habba Hamra	Red seed drink	Soaking red seeds in hot milk	Evaporated milk, red seed, cardamom, saffron, black pepper and sugar
Main dishes			
Harees, beef	Whole wheat with meat	Prolonged cooking under pressure then blended	Whole wheat, meat, water, ghee, salt and cardamom
Thareed, beef	Regag bread with meat stew	Cooked stew poured on Regag bread	Wheat flour, meat, potatoes, onions, tomatoes, zucchini, tomato paste, vegetable oil, spices and water
Biryani, chicken	Basmati rice with chicken	Cooked rice with boiled chicken	Rice, salt, ghee, spices, chicken, garlic and onion
Machbous, fish	Basmati rice with fish	Cooked rice with fried fish	Rice, tomato, onion, water, salt, spices and fish
Arseyah	Basmati rice with chicken	Cooked then blended	Rice, salt, chicken, water, cardamom and cinnamon
Dessert dishes			
Khabisa	Semolina pudding with cardamom	Toasted semolina and caramelised sugar	Semolina, water, ghee, sugar and cardamom
Leqemat	Doughnut cake	Deep frying	White wheat flour, vegetable oil, salt, sugar, egg and yeast
Batheetha	Khalas date paste	Toasted flour mixed with raw date paste	Date fruit, white wheat flour, ghee, sugar, cardamom and cinnamon
Kanfarooosh	Doughnut cake	Deep frying	White wheat flour, yeast, sugar, egg, vegetable oil, saffron, cardamom and baking powder
Balalet	Sweet vermicelli	Stir-frying vermicelli with sugar and ghee	Flour vermicelli, water, sugar, ghee and cardamom

Blood glucose measurements

Before blood collection, participants were asked to warm their hand to increase blood flow. A fasting blood sample (0 min) was then obtained (following the WHO 2010 guidelines for withdrawing blood⁽²³⁾) before consumption of each food and additional blood samples obtained at 15, 30, 45, 60, 90 and 120 min after the consumption of each food. Capillary blood was collected from the third finger on the left hand using the OneTouch[®] UltraSoft[™] Adjustable Blood Sampler (Johnson and Johnson). Squeezing of the finger was avoided to minimise plasma dilution and a 5-µl-blood sample was collected in a microcuvette by capillary action. Blood glucose was measured using the HemoCue Glucose 201+ portable system (HemoCue[®] Ltd). Calibration of the blood glucose meters was done daily according to the manufacturers' instructions.

Calculation of glycaemic index and glycaemic load

The IAUC was geometrically calculated ignoring the area beneath the baseline⁽²²⁾. The IAUC for each test food consumed by each subject was expressed as a percentage of the mean IAUC for the reference food consumed by the same subject:

$$GI = (\text{IAUC for the test food containing (X) g of available carbohydrates}) / (\text{IAUC of a reference food with an equal available carbohydrates portion}) \times 100.$$

The overall GI of each test food was calculated as the mean for the whole group.

The GL of a serving of each test food was calculated by the following formula⁽²⁴⁾:

$$GL = (\text{GI of test food} \times \text{amount of available carbohydrate in a serving of test food (g)}) / 100.$$

The serving size of each test foods was taken from the Photographic Atlas of Food Portions for the Emirate of Abu Dhabi⁽²⁵⁾.

Statistical analysis

A total of fifteen participants or more were used for GI testing of a single food which is more than the minimum requirement recommended by the ISO 26642:2010 standard for GI testing⁽²⁶⁾. All statistical analyses were performed using Minitab software for Windows version 16 (Minitab Inc.).

Results

The proximate analyses data were expressed as means and standard derivations (Table 3). Information from Table 3 was essential for calculating the amount of available carbohydrate (g/100 g) in each test food.

The GI and GL values for all tested foods are given in Table 4. GI values of carbohydrate foods are classified as low (≤ 55), medium (56–69 inclusive) and high (≥ 70) GI foods. The four groups of food included in this study (breads, entrée, main and

Table 3. Proximate analysis of eighteen traditional foods commonly consumed in the United Arab Emirates (g/100 g on a fresh weight basis) (Mean values and standard deviations)

Test food	Moisture (g)		Protein (g)		Fat (g)		Ash (g)		Fibre (g)		Carbohydrates (g)		Energy (kJ)		Energy (kcal)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Arabic bread	25.12	0.34	9.45	0.05	1.15	0.04	0.68	0.04	0.13	0.01	63.61	0.38	1265.91	4.18	302.56	1.14
Regag bread	21.93	0.79	10.49	0.07	0.46	0.01	1.88	0.02	1.23	0.14	65.25	0.73	1284.66	13.60	307.04	3.25
Chebab bread	35.70	2.15	7.08	0.35	9.07	0.83	1.07	0.07	1.20	0.77	47.08	1.51	12478.92	48.28	298.26	11.54
Muhalla bread	15.63	5.91	10.34	0.82	4.24	1.00	1.59	0.27	0.54	0.03	68.20	4.78	1474.23	111.00	352.35	26.53
Khameer bread	18.43	6.42	10.45	0.75	12.69	2.13	1.69	0.27	1.81	0.31	56.74	3.42	1602.35	146.73	382.97	35.07
Fendal	62.48	0.20	1.86	0.02	0.57	0.01	0.55	0.06	2.91	0.05	34.54	0.24	630.57	3.97	150.71	0.95
Chami	77.25	0.23	15.48	0.28	0.66	0.17	1.17	0.18	0.12	0.10	5.44	0.49	374.97	3.10	89.62	0.74
Habba Hamra	80.24	1.60	1.23	0.97	1.84	1.31	0.48	0.05	0.25	0.06	16.21	1.22	361.20	53.14	86.33	12.70
Harees, beef	77.70	1.63	5.55	0.38	2.43	0.84	1.01	0.17	5.56	0.86	13.30	0.92	407.10	45.31	97.30	10.83
Thareed, beef	78.40	0.55	7.04	0.23	2.13	0.08	0.31	0.01	1.26	0.19	12.12	0.34	400.91	10.71	95.82	2.56
Biryani, chicken	63.26	1.34	11.55	0.86	3.28	0.42	1.26	0.12	0.96	0.45	20.65	1.06	662.49	15.56	158.34	3.72
Machbous, fish	68.26	2.24	6.96	1.56	1.98	0.29	1.20	0.12	3.60	0.56	21.60	0.45	552.46	42.30	132.04	10.11
Arseyah	86.66	0.34	2.24	0.04	0.88	0.10	0.11	0.01	0.26	0.01	10.11	0.46	239.93	3.97	57.32	0.95
Khabisa	24.91	4.01	5.38	0.87	10.54	1.60	0.32	0.08	2.72	0.41	58.85	4.56	1471.68	67.45	351.74	16.12
Leqemat	23.26	1.72	7.29	0.28	22.80	2.09	1.02	0.10	1.45	0.34	45.63	1.12	1744.35	70.58	416.91	16.87
Batheetha	16.40	0.14	5.81	0.04	9.54	0.09	1.14	0.07	6.12	0.44	67.11	0.03	1579.71	3.72	377.56	0.89
Khanfaroosh	21.57	2.08	6.72	0.20	30.32	1.91	0.60	0.10	1.16	0.28	40.79	0.77	1936.86	75.52	462.92	18.05
Balalet	55.67	3.50	2.40	0.26	1.72	0.58	0.12	0.04	12.20	1.31	40.09	3.19	776.05	66.48	185.48	15.89

dessert) produced a wide range of GI values ranging from 42 in Harees to 77 in Muhalla bread.

Seven test foods had low GI (Chebab bread, Khameer bread, Harees (beef), Biryani (chicken), Leqemat, Khanfaroosh and Habba Hamra), six were classified as medium GI (Arabic bread, Chami, Machbous (fish), Khabisa, Batheetha and Balalet) and five showed high GI values (Regag bread, Muhalla bread, Fendal, Thareed (beef) and Arseyah).

Discussion

We tested the GI of eighteen traditional Emirati foods, that is five breads, three entrée dishes, five main dishes and five desserts. Among the tested breads, Muhalla bread had the highest GI (mean GI=77) and Khameer bread had the lowest GI (mean GI=47). Of the three entrée dishes tested Fendal was classified as a high-GI food (mean GI=74), Chami as a medium-GI food (mean GI=60) and Habba Hamra as a low-GI food (mean GI=47). Two of the main dishes had a high GI (Thareed and Arseyah), two had a low GI (Harees and Biryani) and one main dish had a medium GI (Machbous). The GI values of sweet dishes tested in the present study ranged from 44 in Leqemat to 67 in Khabisa.

Several factors are known to alter the glycaemic response of food, that is, presence of macronutrients such as fat and protein, type of starch, processing method, and addition of acids, sugars, gelling fibre or amylase inhibitors⁽²⁷⁾. Other factors include the degree of chewing, concentration of amylase in the gut, presence of other food components in the gut, amount of the insulin response and rate of gastric emptying⁽²⁸⁾.

Bread is a staple food that is prepared usually by baking a dough of flour (wheat, rye, rice, oat or barley) and water. Two breads were classified as high GI – Regag bread (mean GI=76) and Muhalla bread (mean GI=77) – and the main dish containing bread was also high in GI, that is – beef Thareed

(mean GI=74). The 2008 international tables of GI and GL reported a mean GI value of 75 (high) for white wheat bread and 70 (high) for unleavened wheat bread⁽¹⁸⁾. Regag and Muhalla breads are unleavened wheat breads with an increased surface area and thinness leading to an increase in the availability of starch for digestion and therefore higher GI response (mean GI=76 and 77, respectively)^(29,30) compared with white wheat bread. The GI values of Regag and Muhalla breads reported in this study are comparable with the GI value of Tanour bread (mean GI=81) reported by Hassan *et al.*⁽³¹⁾. Tanour bread is also a thin type of bread with a large surface area and is usually baked on a crepe oven.

White Arabic wheat bread, also referred to as 'Lebanese bread', had a mean GI value of 67 (medium). Similarly, Ali *et al.* evaluated the GI of eight different types of traditional Omani wheat breads and reported a GI value of 63 (medium) for white Lebanese wheat bread⁽³²⁾. The 2008 international tables of GI and GL reported a mean GI value of 57 for white Pita bread. However, Arabic bread and Pita bread are not the same type of bread, as they differ in thickness and size. Other factors like the type of oven used for baking (gas oven or masonry oven), temperature of the oven and the amount of yeast added could affect the GI. Arabic bread loaf tends to be thinner, larger, leavened and baked in a masonry oven. The effect of sourdough fermentation of leavened baked breads on the GI has been previously reported^(33–36). The effect of sourdough fermentation on the GI of bread was thought to be due to the synthesis of lactic acid which in turn lowers the rate of starch digestion⁽³³⁾, synthesis of acetic and propionic acids, causing a reduction in the gastric emptying rate⁽³⁴⁾, or the synthesis/release of amino acids and peptides, resulting in better regulation of glucose metabolism⁽³⁵⁾. This could explain the lower GI values of Khameer bread (mean GI=47), Chebab bread (mean GI=54) and Arabic bread (mean GI=67) which are considered leavened breads (fermented by yeast) compared with other breads in this study.

Table 4. Glycaemic index (GI) and glycaemic load (GL) values of eighteen traditional foods commonly consumed in the UAE (Mean values with their standard deviations and standard errors)

Test food	Available carbohydrate (g/100 g)			GI		Experimental portion (g)	Standard serving size (g)	Carbohydrate (g/serving)	GL (per serving)	Participants (n)	GI classification	GL classification
	Mean	SD		Mean	SE							
Arabic bread	63.47	0.32		67	5	78.8	90	57.1	38.3	25	Medium	Low
Regag bread	44.37	0.49		76	7	112.7	21	9.3	7.1	25	High	Low
Chebab bread	45.88	1.17		54	8	109.0	77	35.3	19.2	15	Low	Medium
Muhalla bread	67.66	4.79		77	2	73.9	47	31.8	24.5	15	High	High
Khameer bread	54.93	3.47		47	3	91.0	76	41.7	19.5	15	Low	Medium
Fendal	31.64	0.24		74	7	158.0	150	47.5	35.3	20	High	High
Chami	5.31	0.58		60	9	470.8	170	9.0	5.4	16	Medium	Low
Habba Hamra	15.96	1.20		47	3	313.3	98	15.6	7.4	15	Low	Low
Harees	7.74	1.15		42	2	323.0	212	16.4	6.9	15	Low	Low
Thareed (beef)	10.87	0.24		74	3	460.0	245	26.6	19.7	15	High	Medium
Biryani (chicken)	19.69	2.05		52	4	253.9	261	51.4	27.0	15	Low	High
Machbous (fish)	18.00	0.82		60	3	277.8	250	45.0	26.8	20	Medium	High
Arseyah	9.85	0.37		72	4	507.6	261	25.7	18.5	15	High	Medium
Khabisa	56.13	4.65		67	4	89.1	86	48.3	32.1	15	Medium	High
Leqemat	44.19	1.35		44	4	113.1	90	39.8	17.6	15	Low	Medium
Batheetha	38.24	0.97		59	4	130.8	100	38.2	22.7	20	Medium	High
Khanfarroosh	39.62	0.92		45	3	126.2	100	39.6	18.0	15	Low	Medium
Balalet	27.89	2.19		63	5	179.3	144	40.2	25.4	15	Medium	High

Chebab bread and Khameer bread showed low GI values, which might be due to their high protein (7.08 and 10.45 g/100 g, respectively) and fat content (9.07 and 12.69 g/100 g, respectively), and the use of whole-grain wheat flour. Studies suggest that adding fat and protein to foods containing carbohydrates could possibly reduce their glycaemic response and decrease their overall GI^(37,38). It has been proposed that protein stimulates greater gastric inhibitory peptide and higher insulin responses, which in turn lowers the postprandial peak of glucose and reduces the glycaemic response of high-GI foods⁽³⁹⁾. High fat content was shown to delay the rate of gastric emptying, thus reducing the rate of glucose digestion and absorption⁽⁴⁰⁾. Moreover, using whole-grain wheat flour instead of refined wheat flour for the preparation of bread is recommended in order to reduce their high GI values. The presence of dietary fibre in foods could also delay its glycaemic response, as it contributes to slower nutrient absorption and delayed transit time in the small intestines^(22,41).

The GI values of sweet potatoes reported in the literature ranged from 44 (low) to 78 (high)⁽¹⁷⁾ depending on the variety, maturity, cooking method (baking, steaming, roasting, frying or boiling), cutting method (cubing, peeling, mashing or slicing), cooling process and storage conditions (period and temperature)^(42–45). In the current study, Fendal (boiled Beauregard sweet potato, red-orange skin and orange flesh) had a GI of 74 (high). Jenkins *et al.*⁽¹⁾ found that sweet potato from Canada had a GI of 48 while sweet potato (*Ipomoea batatas*) in Australia had a GI of 44 only⁽⁴⁶⁾. However, in New Zealand, Perry *et al.*⁽⁴⁷⁾ reported a GI of 77 for Kumara (sweet potato)⁽⁴⁷⁾. In contrast, the GI for sweet potato that has been peeled, cubed, boiled (in salted water for 15 min) was 59⁽⁴⁸⁾. According to the 2008 international tables of GI and GL values, the mean GI value for boiled sweet potato is 63⁽¹⁸⁾, however, Fendal is an unpeeled whole Beauregard sweet potato boiled in water with the addition of dates to the boiling water as a sweetener which might explain its high GI. It is recommended to precook potatoes and consume them cold (potato salad, for example) or reheated^(42,49), or consuming potatoes with other ingredients such as acetic acid (vinegar)⁽⁵⁰⁾, vinaigrette dressing (vinegar and olive oil added to potato salad)⁽⁵¹⁾ or topping baked potatoes with Cheddar cheese⁽⁴⁰⁾ to lower its glycaemic response.

Chami is a cottage cheese dish which is highly consumed among the Emirati population on a daily basis as part of breakfast (with bread) or as a snack (with dates), therefore it was essential to measure its GI value. Although Chami is not a major source of carbohydrates, its mean GI value was found to be 60. Another milk-based traditional food is the Habba Hamra, which is prepared by soaking red seeds in hot evaporated milk. The low mean GI of 47 for Habba Hamra was expected, as the literature indicated low GI for full-fat milk, ranging from 11 to 46^(17,18).

Rice is the main staple food and energy source for almost half of the world's population. Hence, it has significant nutrition and health implications. Many studies on rice and rice products led to the conclusion that rice should generally be classified as a high-GI food^(52–55). However, many factors could affect the GI of rice and rice products, including rice variety and starch

content (amylose and amylopectin), cooking, processing, cooling, soaking, fibre content and particle size⁽⁵⁵⁾. Moreover, rice is hardly ever consumed on its own; it is often accompanied with other foods such as pulses, legumes, vegetables, seafood, nuts and meats, which could alter the overall GI of the mixed meal. In this study, Biryani, Machbous and Arseyah (mixed rice dishes (rice with chicken or fish)) were found to have low (52), medium (60) and high (72) GI values. The high protein content in Biryani (11.55 g/100 g) along with added vegetables (onion, garlic and pepper) could explain its low GI. In Sri Lanka, par-boiled Mottai Karupan red rice showed a mean GI value of 47 when it was consumed with *Amaranthus* leaf curry, and 56 for parboiled rice with soya meat gravy⁽⁵⁶⁾. The addition of acidic condiments (vinegar or pickles), emulsifiers, dairy products (milk, cheese and yogurt), vegetables, pulses and viscous fibre seems to decrease the GI of mixed meals containing rice⁽⁵⁵⁾. High GI value of Arseyah might be due to prolonged cooking (boiling for 2 h) and blending the rice while being cooked. These cooking methods result in increasing the gelatinisation and digestibility^(57,58) of rice, as well as having an impact on the glycaemic response of the mixed meal⁽⁵⁵⁾. Harees is a traditional dish with a porridge-like consistency; it is prepared from whole wheat with meat (beef or chicken)⁽⁵⁹⁾. The GI value of Harees was the lowest among the traditional dishes studied (mean GI = 42) and this could be explained by its high amount of dietary fibre (5.56 g/100 g)^(22,41). Similarly, the high fat content in Legemat and Khanfaroosh (22.8 and 30.32 g/100 g, respectively) might be the reason behind their low GI values (mean GI = 44 and 45, respectively). Food choice should not solely depend on the GI value of the food, as high fat content – especially saturated fats as in the case of Khanfaroosh and Legemat (13.520 and 9.586 g/100 g, respectively) – defeats the purpose of choosing low-GI foods. Batheetha is a date paste made out of Khalas date fruit mixed with white wheat flour, ghee, sugar, cardamom and cinnamon. Various studies have reported the low GI value of date fruit^(60,61). In 2011, Alkaabi *et al.*⁽⁶¹⁾ reported the mean GI of Fara'd, Lulu, Bo ma'an, Dabbas and Khalas dates tested in thirteen healthy individuals to be 54.0, 53.5, 46.3, 49.1 and 55.1, respectively. In the current study, Batheetha was classified as a medium-GI food (59), possibly due to the sugar (sucrose) added during its preparation. Khabisa and Balalet are Emirati sweet dishes that both contain a high amount of white flour and sugar and have a medium GI value (mean GI = 67 and 63, respectively). The findings of this study advocate attention to the nutritive value and health aspects of traditional desserts when establishing dietary guidelines for the UAE. Traditional desserts should be consumed in moderation due to their medium to high glycaemic response.

In this study, we have demonstrated that the majority of test foods were classified as high GL, which is expected as most of the test foods had high GI. However, the GL value is dependent on food portion size which tend to vary greatly between countries and even within a country. The results presented here should therefore be used and interpreted with caution. We recommend that dietitians calculate their own GL values using the GI data provided.

A limitation of the current study was purchasing test foods 1 d before the test, and refrigerating them until use. Refrigeration has

been suggested to affect the GI of foods through starch retrogradation and the formation of resistance starch, which reduces the amount of starch available for digestion and in turn might reduce the GI of the test foods^(62,63).

In conclusion, this study provides GI and GL values of eighteen locally consumed foods in the UAE. Determining the nutritional composition and the glycaemic response of Emirati traditional foods is important and key in assessing the dietary intake of the population which could be useful for health promotion and disease prevention. In addition, these tables could be used as a guide for nutrition therapy planning and dietary management for dietitians in the UAE and other Gulf Cooperation Council (GCC) countries. In addition, knowing the GI and GL values of traditional Emirati foods helps in developing better dietary guidelines and food choices for individuals living with diabetes and/or obesity.

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