REVIEW ARTICLE

Oman Medical Journal [2018], Vol. 33, No. 4: 273-282

Diabesity in the Arabian Gulf: Challenges and Opportunities

Aly Bernard Khalil[1]*, Salem A Beshyah[2], Nabila Abdella[3], Bachar Afandi[4], Mounira M Al-Arouj[5], Fatheya Al-Awadi[6], Mahmoud Benbarka[7], Abdallah Ben Nakhi[5], Tarek M Fiad[2], Abdullah Al Futaisi[8], Ahmed AK Hassoun[9], Wiam Hussein[10], Ghaida Kaddaha[11], Iyad Ksseiry[12], Mohamed Al Lamki[13], Abdulrazzak A Madani[6], Feryal A Saber[14], Zeyad Abdel Aal[15], Bassem Morcos[15] and Hussein Saadi[16]

[1]Department of Endocrinology, Imperial College London Diabetes Center, Abu Dhabi, UAE
[2]Center for Diabetes and Endocrinology, Sheikh Khalifa Medical City, Abu Dhabi, UAE
[3]Department of Medicine, Faculty of Medicine, University of Kuwait City, Kuwait City, Kuwait
[4]Department of Endocrinology, Tawam Hospital, Al-Ain, UAE
[5]Department of Diabetes, Dasman Diabetes Institute, Kuwait City, Kuwait
[6]Department of Endocrinology, Dubai Hospital, Dubai, UAE
[7]Department of Endocrinology, Health Plus, Abu Dhabi, UAE
[8]Department of Endocrinology, Sultan Qaboos University Hospital, Muscat, Oman
[9]Department of Diabetes, Dubai Diabetes Center, Dubai, UAE
[10]Department of Endocrinology, Dr. Wiam Clinic for Diabetes and Endocrine Disorders, Riffa, Bahrain
[11]Department of Diabetes and Endocrinology, Suliman Al Habib Hospital, Dubai Medical City, Dubai, UAE
[12]Department of Diabetes and Endocrinology, Mediclinic Hospital, Dubai, UAE
[13]Department of Diabetes and Endocrinology, Royal Hospital, Muscat, Oman
[14]Department of Diabetes and Endocrinology, Bahrain Defense Force Hospital, Riffa, Bahrain
[15]Medical Affairs, Merck Sharp and Dohme Corp., Dubai, UAE
[16]Medical Subspecialties Institute, Cleveland Clinic Abu Dhabi, Abu Dhabi, UAE

ARTICLE INFO

Article history:
Received: 1 December 2017
Accepted: 5 March 2018

Online:
DOI 10.5001/omj.2018.53

Keywords:
Obesity; Diabetes; Lifestyle; Bariatric Surgery; Ethnic Groups; Arab Countries.

ABSTRACT

Diabesity (diabetes associated with obesity) is a major global and local public health concern, which has almost reached an epidemic order of magnitude in the countries of the Arabian Gulf and worldwide. We sought to review the lifestyle trends in this region and to highlight the challenges and opportunities that health care professionals face and attempt to address and correct them. In this regard, we aimed to review the regional data and widely held expert opinions in the Arabian Gulf and provide a thematic review of the size of the problem of diabesity and its risk factors, challenges, and opportunities. We also wished to delineate the barriers to health promotion, disease prevention, and identify social customs contributing to these challenges. Lastly, we wished to address specific problems with particular relevance to the region such as minimal exercise and unhealthy nutrition, concerns during pregnancy, the subject of childhood obesity, the impact of Ramadan fasting, and the expanding role of bariatric surgery. Finally, general recommendations for prevention, evidence-based, and culturally competent management strategies are presented to be considered at the levels of the individual, community, and policymakers.

The Arabian Gulf region refers to the six member states of the Gulf Cooperation Council (GCC) countries namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia (KSA), and the United Arab Emirates (UAE). Their estimated population is about 52 million. The rapid socioeconomic development of the GCC has resulted in major demographic and epidemiological transitions, with obesity, a high prevalence of diabetes, and chronic diseases becoming the leading causes of morbidity and mortality.[1] Factors underpinning this increasing prevalence of obesity and type 2 diabetes mellitus (T2DM) are multifactorial and primarily related to economic development, and the parallel shift in culture, lifestyle, and dietary habits.

Obesity is the most important risk factor for developing glucose intolerance. The high prevalence of obesity in the Gulf countries has led to a marked rise in the prevalence of prediabetes and diabetes.[2] The various components of metabolic syndrome are established risk factors among patients presenting for coronary artery bypass grafting in one study from the

*Corresponding author: ✉akhalil771@gmail.com

region.[3] The prevalence of obesity in GCC countries among children and adolescents ranges from 5% to 14% in males and 3% to 18% in females. In adult women, there is a significant increase of obesity with a prevalence of 8–36% in men and 17–48% in women.[4] The International Diabetes Federation (IDF) reported high prevalence rates of more than 20% for diabetes and more than 15% for prediabetes in most GCC countries. These are among the highest rates worldwide.[5]

Diabesity (diabetes associated with obesity) is a major global and local public health concern, which has almost reached an epidemic order of magnitude in countries of the Arabian Gulf and worldwide. This is a narrative, thematic non-systematic review of the literature. We have five objectives for this review article. Firstly, to consider the lifestyle trends in the Gulf area. Secondly, to highlight the challenges and opportunities that healthcare professionals and workers would have to face and correct. Thirdly, to explore the barriers to health promotion and disease prevention. Fourthly, to elaborate on special considerations relevant to the region such as pregnancy, childhood obesity, food supplements, and the nutritional impact of Ramadan fasting, and the expanding role of bariatric surgery. Finally, to present general recommendations for prevention as well for effective evidence-based and culturally competent management strategies at the individual, community, and policymaker level to help curtail the problem of diabesity effectively.

Factors contributing to diabesity in the Gulf region

Nutritional and eating patterns in the Gulf region

Food consumption and nutrient intake in Arabian Gulf countries have altered during the past four decades due to increased income and urbanization.[6] Although meal patterns may be minimally different between different parts of the region, they tend to have many features in common. The traditional Gulf diet, high in fiber and low in fat, was recently replaced by a Western diet, which is rich in fat, saturated fats, sodium, cholesterol, free sugars, and added sugars. [7] It has been shown that majority of Saudi's and Omani's, for example, consume three meals daily with lunch being the main meal. Rice with meat (mutton or chicken) and salad are habitually the main food items consumed for lunch.[8] An increase in snacking on junk foods particularly by school children is noticeable.[8,9] There has also been a tendency for a reduced dietary fiber and essential nutrients due to insufficient intake of fruits and vegetables. Only 38% of the population reported eating fresh vegetables, and 40% consume fruits daily.[6] These trends in eating habits have been perpetuated by an ever-increasing tendency for dining out and consumption of energy-dense food products.[6] Another noticeable trend is skipping of breakfast both by school children and working adults. A study conducted in Bahrain reported that about 19% and 22% of school-aged males and females skip breakfast, respectively.[10] A similar pattern was also observed in 15% and 49% of Saudi adolescent males and females, respectively. Interestingly, a positive correlation was found between skipping breakfast and risk of overweight and obesity.[11] In the long term, individuals who skip breakfast in childhood and adulthood were shown to have larger waist circumference and higher fasting insulin, total cholesterol, and low-density lipoprotein (LDL) cholesterol concentrations than those who eat breakfast regularly.[12]

Nutritional studies in the Gulf region

Since the typical Gulf diet is a high-energy diet, a carbohydrate- or calorie-restricted diet would expectedly be effective in reducing weight and comorbidities. Studies to elucidate this aspect in the Gulf are mostly small interventional or only observational [Table 1]. In adult Emirati patients, a study was conducted to determine whether a first-line therapy intervention for weight reduction would improve the characteristics of metabolic syndrome.[13] At six and 12 weeks, positive changes were observed for all participants, independent of diet [Table 1]. In another study, 132 individuals with severe obesity, many of whom had metabolic syndrome or T2DM were randomized to either a low-fat (calorie-restricted) or a low-carb diet for six months.[14] Overall, the low-carb diet had more beneficial effects [Table 1].

Physical activity

Clinical aspects of exercise

Physical exercise improves insulin sensitivity, modifies lipid abnormalities, and lowers blood pressure.[15] Physical activity should regularly be undertaken to

Table 1: Studies elucidating the metabolic impact of dietary modifications in the Gulf.

Authors	Subjects and methods	Results and conclusions
Al-Sarraj et al.[13] (UAE)	n = 39; aged 18–50 years; with metabolic syndrome put on CRD* for six weeks then 20 switched to AHA diet. Outcome measures were recorded at weeks 0, 6, and 12.	High compliance with diet. six week on CRD decreased body weight (-13%), WC (-4.5%), body fat (-10.6%), and plasma TG (-38.7%). LDL cholesterol, BP, FPG, insulin, and inflammatory markers also decreased and adiponectin increased ($p < 0.050$).
Samaha et al.[14] (UAE)	132 individuals with severe obesity** were randomized to either a LFD or LCD for six months.	Weight loss of 1.9 kg vs. 5.8 kg were observed on LFD and LCD, respectively. TG, insulin, and FPG levels were lower on LCD.

AHA: American Heart Association; CRD: carbohydrate-restricted diet; LCD: low-carbohydrate diet; LFD; low-fat diet; LDL: low-density lipoprotein; BP: blood pressure; TG: triglycerides; FPG: fasting plasma glucose; WC: waist circumference.
**Carbohydrate-restricted diet of 20–25% carbohydrate, 50–55% fat, 25–30% protein energy distribution.*
***Many had metabolic syndrome or type 2 diabetes mellitus.*

maintain the beneficial effect on insulin sensitivity, which is usually lost within 72 hours of the last exercise session.[15] The Canadian Diabetes Guidelines (2016) recommend at least 150 minutes per week of aerobic exercise, plus at least two sessions per week of resistance exercise.[16] Furthermore, a study of over one million people suggested that daily physical activity of one hour or more may eliminate the increased risk of death associated with sitting for eight hours a day. Such physical activities included brisk walking at 5.6 km/h or cycling for pleasure at 16 km/h.[17] On the other hand, there is a compelling body of evidence that a sedentary lifestyle and lack of physical activity increase the risks of many non-communicable diseases such as obesity, T2DM, cardiovascular disease, stroke, some cancers, and premature mortality.[18] Many adults globally and in the Gulf region in particular, do spend the majority of their waking hours (i.e., 50–70%) engaged in sedentary behavior while in a sitting position.[19,20] Several factors have facilitated such choice of sedentary lifestyles. Mechanization, automation, computerization, and organization of work and household chores have led to a marked reduction in physical activity. Increased TV viewing at all ages, particularly during childhood, and more notably in lower socioeconomic status, has led to an unhealthy lifestyle. Indeed, people considered thin are less likely to take exercise and more likely to snack frequently.[17,21] As a person ages, lack of physical activity causes about 20–40% decline in muscle integrity, strength, and power.[22]

Regional studies on exercise and sedentary lifestyle

Given the rates of physical inactivity and diabetes in Gulf countries are among the highest in the world, there is obviously an urgent need for population-based public health approaches to promote regular physical activity. Several studies documented the low uptake of physical activity in the general adult population and high-risk groups (e.g., diabetics) from three different countries.[23–26] These studies are summarized in Table 2. Furthermore, a recent review also concluded that participation in physical activity, defined as 150 minutes per week or more, is low and was reported in adults as around 40% for men and 27% for women.[27]

Contribution of myths and culture to diabesity in the Gulf

Most common myths and misconceptions in the Gulf are related to traditional therapy trends, and information received from non-professional sources. The perceived personal, social, and environmental barriers to healthy eating among Arab adolescents were evaluated in a large study of 4698 students aged 15–18 years from seven Arab countries.[28] The main obstacles to healthy eating among both genders were identified. These included lack of information on healthy eating, lack of motivation to eat a healthy diet, and having no time to prepare or eat healthy food. Reportedly, it was perceived easier and more convenient to eat fast foods from restaurants with delivery services, vending machine snacks, and processed foods than to consume self-prepared and cooked healthy foods. Dietary practices and barriers to a healthy diet were evaluated in 409 diabetic patients attending hospital outpatient clinics in Al-Ain , UAE.[29] Only a quarter read food labeling, over three-quarters reported being unable to distinguish clearly between low and high carbohydrate index food items. No one reported counting calorie intake and nearly half indicated

Table 2: Summary of salient studies on diet and exercise in three countries from the Gulf region.

Authors (country)	Research question and population	Results and conclusions
Serour et al.[23] (Kuwait)	To measure adherence to lifestyle measures among patients with high cardiovascular risk. A prospective study of 334 adults with hypertension, T2DM, or both, who completed a routine clinic visit in one of six family practice centers.	63.5% of patients were not adhering to diet and 64.4% were not exercising regularly. 90.4% were overweight or obese. Barriers to adherence to diet were unwillingness (48.6%), difficulty adhering to a diet different from that of the rest of the family (30.2%), and social gatherings (13.7%). Barriers to exercise included lack of time (39.0%), coexisting diseases (35.6%), and adverse weather conditions (27.8%). Factors interfering with adherence to lifestyle measures were traditional food, stress, high consumption of fast food, high frequency of social gatherings, an abundance of maids, and excessive use of cars.
Al-Hazzaa.[24] (KSA)	Health-enhancing physical activity among 1061 adults (15–78 years).	43% did not have any moderate-intensity physical activity lasting ≥10 min; 72% did not engage in any vigorous-intensity physical activity lasting ≥ 10 minutes. 33.3% walked ≥ 150 min/week. Females were engaged more in moderate physical activity whereas males participated more in vigorous activity. No relationship with educational level or work hours.
Al-Nozha et al.[25] (KSA)	Physical activity among 17 395 adults (30–70 years); (from the Coronary Artery Disease in Saudis Study carried out in 1995–2000).	Inactivity prevalence was very high (96.1%). There were more inactive females (98.1%) than males (93.9%), ($p <$ 0.001). Inactivity increases with increasing age, especially in males, and decreases with increasing education levels. Active individuals had lower BMI and WC values.
Al-Kaabi et al.[26] (UAE)	Physical activity and reported barriers to activity among T2DM patients.	25% of the diabetic patients reported an increase in their physical activity following the diagnosis of diabetes but only 3% met the recommended physical activity level.

KSA: Kingdom of Saudi Arabia; T2DM: type 2 diabetes mellitus; UAE: United Arab Emirates; WC: waist circumference; BMI: body mass index.

that they had never been seen by dietician since their diagnosis. Also, the factors influencing dietary practices of 400 T2DM patients attending primary health care centers in Bahrain were evaluated.[30] The majority were 50 years old with low educational level. Most were overweight and obese and had poor diabetes control; 14% denied receiving any dietary advice, and 16.3% received advice from the diabetic nurse. Most patients have never been referred neither to a dietician (79.5%) nor a health educator (84.5%). The two main barriers to dietary regimen were 'it takes efforts' in 45.8% and 'being busy' in 45.5%.

As such, many decision makers and patients do not consider nutritional education an essential part of the treatment of diabesity. This makes education about diet and diabetes tough to implement and follow-up. Also, there is an insufficient number of certified nutritionists and educators in the region to fill the gap despite genuine attempts by some health authorities in the Gulf region to establish diabetes educator programs. More importantly perhaps is the habit of consuming a lot of carbohydrates either in the form of dates or sugary drinks. Dates are usually consumed habitually on an individual basis with daily coffee, as part of a social hosting custom or in abundance at seasonal times of harvesting.[31] Soft drinks sales in the GCC are among the highest in the world. About 40% of total sales come from carbonates amounting to 88 liters per capita in KSA.[32] Juices are the second largest component at US$2.3 billion, driven by the UAE (which ranks first globally in per capita consumption).

Other social factors in the Arabian Gulf are noteworthy. For instance, eating from the same plate by all family members may adversely affect the quantity of food consumed as it is neither measurable nor individually divided.[33] This may encourage some to eat more than others. There is also, at times, a tendency for patients not to disclose their diabetic condition in social circles for fear of looking different and hence would not observe their food intake. Another observed factor is the perceived tolerance to fatness. It has also been suggested that no social sanctions against adiposity exist in some parts of the Gulf.[34] Men's influence on determining women's attitudes towards body size is possibly another contributor. In Qatar, for example, about 43% of Arab women believed that men preferred overweight women.[35] Furthermore, the traditional dress may indirectly contribute to obesity in some countries in the region. The traditional long and wide clothes of men and women may mask the degree of fatness and consequently reduce the motivation to lose weight.[36]

Emerging issues in the Gulf

The expanding use of bariatric surgery

The trend towards performing bariatric surgery in the Gulf region has increased tremendously. There are only a few well-established governmentally run multidisciplinary programs, and their results are so far promising.[37] In general, outcomes of bariatric surgery were similar for most postoperative variables to those achieved at American counterpart institutions.[38] Short-term postoperative outcomes (weight and comorbidity parameters) following laparoscopic Roux-en-Y gastirc bypass as the primary procedure performed in Ajman, UAE was reported.[39] Postoperative improvement was seen in all parameters, and an average excess weight loss of 68% was observed at 12 months. Additionally, lipid profiles and glycated hemoglobin (HbA_{1c}) were significantly better at 12 months. Laparoscopic sleeve gastrectomy surgeries at Dubai Hospital resulted in a significant boday mass index (BMI) loss and were associated with resolution of diabetes and hypertension in 68.8% and 57.8% of patients, respectively.[40]

Unfortunately, the positive effects on weight reduction and improved glycemic effect observed with low-calorie diets and bariatric surgery are negatively challenged with potential micronutrients losses and the false belief by most patients that the surgery is the only step with no need for continuous lifelong monitoring. To start with, obese individuals tend to have relatively high rates of micronutrient deficiencies before surgery, which is compounded by further losses after surgery (biotin, thiamine, vitamin E, vitamin C, chromium, zinc, and selenium).[41] Therefore, there is an urgent need for further education, regulation, and monitoring concerning bariatric surgery. This will assure initial assessment for the appropriateness of the surgery and subsequently guarantee appropriate follow-up. This may be best achieved through the establishment of appropriate collaborative, multidisciplinary team programs, and transnational scientific and professional societies. Even board-type certification in bariatric medicine on regional basis guided by international experience may be needed.

Sugar substitutes

The six GCC countries represent a US$8.4 billion soft drinks market. In 2015, Saudi's received 35% of their sugar from soft drinks. That is nearly double the global average and is above the comparable figure for carbonates-loving countries like the US (29%) and Mexico (32%). There has been an increased use of artificial sweeteners as a means to reduce excess calorie and sugar intake.[4] Large epidemiologic studies support an association between artificially sweetened beverage consumption and weight gain in children. One mechanism proposed is decreased hedonic brain response post-consumption of artificially sweetened beverages leading to a feeling of satisfaction, which may fuel further food consumption.[32] This emerging concept of possible adverse metabolic effects attributed to sweeteners has been lately downsized due to limited randomized controlled trials. In fact, there is still no strong clinical evidence for causality regarding artificial sweetener use and metabolic health effects.[42] More studies in this area are badly needed globally and regionally.

Dietary supplements

Over the past two decades, there has been a near-explosive trend worldwide for the use of herbal and dietary supplements (DS). DS include multivitamins, phytochemicals, and antioxidants as part of 'alternative,' 'integrative,' or 'complementary' care. Examples of common herbal products used in the region include, *helba* (fenugreek), cinnamon, and mixtures of Arabic and Indian herbs and spices. In one study, the 10 most commonly used DS (in descending order) were: fish oil/omega-3-fatty acids, glucosamine, echinacea, flaxseed, ginseng, combination herb pills, gingko biloba, chondroitin, garlic, and coenzyme Q10.[43] Furthermore, 63 prospective randomized controlled trials were reviewed and found that, with the possible exceptions of vitamin D and omega-3-fatty acids, insufficient evidence to support the routine use of DS and many agents were associated with harm due to interactions with concomitant drug administration.[44]

Endocrine-disrupting chemicals

The rising obesity trends have been linked to possible exposure to end-products of pollution associated with the spread of industrial chemical production and environmental exposure to endocrine-disrupting chemicals (EDCs). These include chemical compounds such as bisphenol A (PBA) and alkylphenols; or organophosphate pesticides and perchlorates found in a broad range of products.

Pesticides, paints, adhesives, and plastics, as well as in nearly all industrial goods and, most concerning, in foods as preservatives and artificial sweeteners have all been incriminated.[45,46] These EDCs may act by mimicking or disrupting metabolic pathways affecting insulin resistance and inducing weight gain. Release of these chemicals into natural waters and wastewater treatment plants are expected to have detrimental effects on wildlife and humans. Organophosphate pesticides were used during recent armed conflicts in the region.[47] Their long-term effects are still to be seen. Similarly, the growing habit of consuming preserved water in plastic bottles exposed to a high environmental temperature in the Gulf region may be another problem. There is an urgent need to conduct further studies in this area to resolve these concerns. In the interim, simple instructions should be given to the public. These measures include washing hands thoroughly after use of industrial products such as paints, fertilizers, adhesives, cleaning agents, and lawn and garden treatments, and also washing fruits and vegetables thoroughly before consuming or cooking them. Further measures include using organic fertilizers and cleaning products and avoiding the use of plastic food containers. Finally, maintaining adequate dietary iodine (i.e., through the use of iodized salt) is recommended to minimize the effect of perchlorate exposure.

Special circumstances

Childhood obesity

Childhood obesity is a growing problem in the Gulf region. Some contributing factors include eating outside the home, television and computer viewing for long hours, eating while watching television, exposure to food advertising, extra snacking, and lack of physical activity. Eating outside the home has increased in primary school children (6–11 years).[48] The proportion of obesity exceeded 50% among those who eat outside the home more than five times per week.[48] Eating outside home was significantly associated with childhood obesity ($p < 0.001$). In KSA, obese preschool children (4–6 years) watched television significantly longer than non-obese children (197 vs. 150 minutes per day, $p < 0.001$).[49] In Bahrain, more obese adolescents (57%) consumed their main meals (lunch and supper) while watching television than non-obese (46%) adolescents. Chocolates, sweets, potato chips, soft drinks, and nuts were reportedly the main foods consumed while watching television.[50] Exposure to food advertising, especially TV commercials, may influence the viewers' food choices. The main television food advertisements preferred by children (5–12 years) included fast foods, chocolate and sweets, milk, and soft drinks (43%, 41%, 40%, and 38%, respectively).[51] The authors of one study used the Global Burden of Disease (GBD) 2015 study results to explore the burden of high BMI in the Eastern Mediterranean Region.[52] They calculated that the prevalence of obesity increased for adults from 15.1% in 1980 to 20.7% in 2015 and from 4.1% to 4.9% for the same period among children (aged 2–19 years). In 2015, there were 417 115 deaths and 14 448 548 disability-adjusted life years (DALYs) attributable to high BMI in the region, which constitute about 10% and 6.3% of total deaths and DALYs, respectively, for all ages. The author called to invest resources in prevention and health promotion efforts to reduce this burden.[52]

Impact of pregnancy and breastfeeding

Some studies have linked weight changes during pregnancy and breastfeeding to the development of obesity later in life. A direct linear association was observed between higher parity and obesity ($p < 0.001$). Breastfeeding was also considered potentially protective against weight gain in childhood. A study from Kuwait refuted this concept and reported that neither breastfeeding nor its duration was associated with childhood obesity when potential confounders were controlled for.[53] Whether the introduction of solid foods to the infants before two months is linked to obesity remains unproven.[53] One study showed that children who received solid foods before two months of age were two-times at risk of becoming overweight than those who received solid foods later.[53] Further studies are needed in the Gulf region to elucidate the relationship of obesity with parity and breastfeeding practices.

Nutritional impact of Ramadan fasting

In principle, fasting is meant to reduce energy consumption and glucose toxicity, and facilitate weight reduction. Studies on nutritional status during Ramadan have encompassed multiple aspects such as body weight and body composition,

hydration status, and energy expenditure. Changes in various metabolic parameters of glucose and lipid metabolism, biochemical and hematological, and biochemical measures of liver, kidney, and immunological functions have also been investigated.[54] The impact of fasting on intermediary metabolic changes in glucose homeostasis produce decreases in fasting glucose, insulin, and insulin resistance after four weeks in healthy normal weight individuals with mild weight loss (1–2% from baseline). Ramadan fasting lowers body weight, body fat percentage, and BMI. Although weight decreased during Ramadan in most studies, weight regain is prevalent during the following months.[55] This is because the concept of Ramadan fasting has been deformed in the GCC and some other Muslim countries to become a month of overabundance in nutrient consumption. Logically, adherence to dietary discretions and moderate physical exercise during Ramadan may enhance the opportunities for weight loss without increased risk of hypoglycemia. Individualized education and diabetes treatment programs were shown to help patients with T2DM achieve a safer fast during Ramadan, and perhaps lose some weight and improve their glycemic control.[55] Although several studies have shown that Ramadan fasting had no serious adverse effect on offspring, it is recommended that pregnant women should avoid fasting because of the limitations of these studies and the clear religious guidance for their exemption.[56]

Prediction of future trends

Important studies were published on prediction future trends in obesity and diabetes in the Gulf region.[57,58] The prevalence of obesity among adults in KSA increased from 22% in 1990–1993 to 36% in 2005, and future projections of the prevalence of adult obesity are needed by health policy-makers. In a secondary analysis of published data, a number of assumptions were applied to estimate the trends and projections in the age-and sex-specific prevalence of adult obesity in KSA from 1992–2022.[57] Five studies conducted between 1989 and 2005 were eligible for inclusion, using BMI ≥ 30 kg/m^2 to define obesity. The overall prevalence of obesity was projected to increase from around 12% in 1992 to 41% by 2022 in men, and from 21% to 78% in women. Women had much higher projected prevalence than men, particularly in the 35–44, 45–54, and 55–64 years age groups. Effective national strategies are needed to reduce or halt the projected rise in obesity. The same group compared estimates and projections of T2DM prevalence in KSA from a validated Markov model against other modelling estimates.[58] A discrete-state Markov model was developed and validated that integrates data on population, obesity, and smoking prevalence trends in adult Saudis aged ≥ 25 years to estimate the trends in T2DM prevalence (annually from 1992 to 2022). The model was validated by comparing the age- and sex-specific prevalence estimates against a national survey conducted in 2005. Prevalence estimates from this new Markov model were consistent with the 2005 national survey and very similar to the GBD study estimates. Prevalence in men and women in 2000 was estimated by the GBD model at 17.5% and 17.7%, respectively, compared to 17.7% and 16.4% in this study. The IDF estimates of the total diabetes prevalence were considerably lower at 16.7% in 2011 and 20.8% in 2030, compared with 29.2% in 2011 and 44.1% in 2022 in this study.

Diabesity in the Gulf: The way forward

We have convincingly argued that diabesity is a major global and regional public health challenge. It has reached an epidemic order of magnitude in the Gulf region. Identifiable factors are multiple and difficult to tackle at the individual level. Concerted efforts are urgently needed to address this ever-expanding problem. Major efforts should be made to reinforce healthy lifestyle education through the production of educational and awareness tools and materials in layperson language. These should be disseminated to the general public, schools, and the media. Misconceptions and wrong beliefs about unproven dietary regimens should be discouraged. The role of medical educators should be recognized. The number of medical nutritionists should be increased at all levels of diabetes clinics namely, primary care, hospitals, and specialized centers. Although the dietary pattern in the Gulf region is mostly that of high carbohydrate and high fat consumption, there is no evidence to specify the ideal proportions of calories from carbohydrate, protein, and fat for people with diabesity. Consequently, macronutrient distribution should be based on individualized assessment of pre-existing eating patterns, preferences, and metabolic goals with a preferential push towards the well-established low-carbohydrate Mediterranean, and dietary approaches to stop hypertension diets.

The rates of physical inactivity and diabetes in the Gulf are among the highest in the world. There is an urgent need for population-based public health approaches to promote physical activity as the norm rather than the exception. Healthy lifestyle promotion should target, in particular, children at home and school. Similarly, the recent World Health Organization recommendations on sugary soft drinks need to be implemented promptly. Furthermore, it is the responsibility of policy-makers to limit the access to the market of high-energy food items. Steps in this direction have already been contemplated in KSA where imposition of taxation on sugary beverages is being considered. There is a growing trend towards bariatric surgery in the Gulf region. Regulation with accreditation and clinical governance should lead to appropriate patient selection for bariatric surgery by multidisciplinary teams only. The role of micronutrients should be addressed with all patients in the pre- and postoperative stages. Structured education should be employed to enlighten people on proper fasting to achieve the expected benefits from Ramadan.

Research based in the Gulf region on the biological, environmental, and cultural basis of the diabesity should be encouraged and supported. In 2007, health authorities of the GCC countries launched the 'GCC Action Plan' for the prevention and control of diabetes over a 10-year period (2008–2018).[59] The plan was endorsed by the Dubai Declaration on Diabetes and Chronic Non-Communicable Diseases in the Middle East and North Africa Region in 2010. Although reports sponsored by the pharmaceutical industry from some of the Gulf countries found the status of diabetes care to be suboptimal,[60] formal interim and final reports on the outcomes of the 'GCC Action Plan' are eagerly awaited.

Disclosure
The authors declared no conflicts of interest. No funding was received for this study.

Acknowledgements
Merck, Sharp and Dohme (MSD) Gulf unconditionally facilitated the convening of the writing group and provided many of the references at the request of authors. Zeyad Abdel Aal and Bassem Morcos are employees of MSD Gulf.

REFERENCES

1. Nikoloski Z, Williams G. Obesity in Middle East. Metabolic syndrome: A Comprehensive Textbook; 2016. p. 55-72.
2. Alharbi NS, Almutari R, Jones S, Al-Daghri N, Khunti K, de Lusignan S. Trends in the prevalence of type 2 diabetes mellitus and obesity in the Arabian Gulf States: systematic review and meta-analysis. Diabetes Res Clin Pract 2014 Nov;106(2):e30-e33.
3. Pieris RR, Al-Sabti HA, Al-Abri QS, Rizvi SG. Prevalence pattern of risk factors for coronary artery disease among patients presenting for coronary artery bypass grafting in Oman. Oman Med J 2014 May;29(3):203-207.
4. ALNohair S. Obesity in gulf countries. Int J Health Sci (Qassim) 2014 Jan;8(1):79-83.
5. International Diabetes Federation. IDF Diabetes Atlas. 8th ed. 2017 [cited 2017 January 12]. Available from: www.diabetesatlas.org.
6. Abuzaid OI. Eating patterns and physical activity characteristics among urban and rural students in Saudi Arabia. University of Nebraska; 2012.
7. Musaiger AO; Arab Centers for Nutrition. The Food Dome: dietary guidelines for Arab countries. Nutr Hosp 2012 Jan-Feb;27(1):109-115.
8. Ministry of Health (Saudi Arabia). General Directorate of Nutrition. Dietary guidelines for Saudis: The healthy food palm. 2012 [cited 2017 March 13]. Available from: https://www.moh.gov.sa/en/Ministry/MediaCenter/Publications/Documents/final%20english%20%20%D8%A7%D9%84%D9%83%D8%AA%D8%A7%D8%A8%20%D8%A7%D9%84%D8%B9%D9%84%D9%85%D9%8A%20%D8%A5%D9%86%D8%AC%D9%84%D9%8A%D8%B2%D9%8A.pdf.
9. Department of Nutrition, Ministry of Health (Oman). The Omani guide to healthy eating. 2009 [cited 2017 February 13]. Available from: http://www.fao.org/3/a-as845e.pdf.
10. bin Zaal AA, Musaiger AO, D'Souza R. Dietary habits associated with obesity among adolescents in Dubai, United Arab Emirates. Nutr Hosp 2009 Jul-Aug;24(4):437-444.
11. Horikawa C, Kodama S, Yachi Y, Heianza Y, Hirasawa R, Ibe Y, et al. Skipping breakfast and prevalence of overweight and obesity in Asian and Pacific regions: a meta-analysis. Prev Med 2011 Oct;53(4-5):260-267.
12. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. Am J Clin Nutr 2010 Dec;92(6):1316-1325.
13. Al-Sarraj T, Saadi H, Volek JS, Fernandez ML. Carbohydrate restriction favorably alters lipoprotein metabolism in Emirati subjects classified with the metabolic syndrome. Nutr Metab Cardiovasc Dis 2010 Dec;20(10):720-726.
14. Samaha FF, Iqbal N, Seshadri P, Chicano KL, Daily DA, McGrory J, et al. A low-carbohydrate as compared with a low-fat diet in severe obesity. N Engl J Med 2003 May;348(21):2074-2081.
15. Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, et al. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement executive summary. Diabetes Care 2010;33(12):e147-e167.
16. Cheng AY; Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 clinical practice guidelines for the prevention and management of diabetes in Canada. Introduction. Can J Diabetes 2013 Apr;37(Suppl 1):S1-S3.
17. Ekelund U, Steene-Johannessen J, Brown WJ, Wang Fagerland M, Owen N, Powell KE. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonized meta-analysis of data from more than 1 million men and women. Lancet 2016;388:1302-1310.
18. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT; Lancet Physical Activity Series Working Group. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 2012 Jul;380(9838):219-229.

19. Al-Sendi AM. Prevalence and determinants of obesity among adolescents in Bahrain. London School of Hygiene & Tropical Medicine. 2002 [cited 2017 February]. Available from: https://researchonline.lshtm.ac.uk/682266/1/289855.pdf.
20. Bakrania K, Edwardson CL, Bodicoat DH, Esliger DW, Gill JM, Kazi A, et al. Associations of mutually exclusive categories of physical activity and sedentary time with markers of cardiometabolic health in English adults: a cross-sectional analysis of the Health Survey for England. BMC Public Health 2016 Jan;16:25.
21. Inyang MP, Okey-Orji S. Sedentary lifestyle: health implications IOSR J Nursing Health Sc. IOSR-JNHS 2015;4(2):20-25.
22. Faghri P, Stratton K, Momeni K. Sedentary lifestyle, obesity, and aging: implication for prevention. Nutr Disorders Ther 2015;5(1).
23. Serour M, Alqhenaei H, Al-Saqabi S, Mustafa AR, Ben-Nakhi A. Cultural factors and patients' adherence to lifestyle measures. Br J Gen Pract 2007 Apr;57(537):291-295.
24. Al-Hazzaa HM. Health-enhancing physical activity among Saudi adults using the International Physical Activity Questionnaire (IPAQ). Public Health Nutr 2007 Jan;10(1):59-64.
25. Al-Nozha MM, Al-Hazzaa HM, Arafah MR, Al-Khadra A, Al-Mazrou YY, Al-Maatouq MA, et al. Prevalence of physical activity and inactivity among Saudis aged 30-70 years. A population-based cross-sectional study. Saudi Med J 2007 Apr;28(4):559-568.
26. Al-Kaabi J, Al-Maskari F, Saadi H, Afandi B, Parkar H, Nagelkerke N. Physical activity and reported barriers to activity among type 2 diabetic patients in the United Arab Emirates. Rev Diabet Stud 2009;6(4):271-278.
27. Mabry RM, Reeves MM, Eakin EG, Owen N. Evidence of physical activity participation among men and women in the countries of the Gulf cooperation council: a review. Obes Rev 2010 Jun;11(6):457-464.
28. Musaiger AO, Bader Z, Al-Roomi K, D'Souza R. Dietary and lifestyle habits amongst adolescents in Bahrain. Food Nutr Res 2011;55.
29. Al-Kaabi J, Al-Maskari F, Saadi H, Afandi B, Parkar H, Nagelkerke N. Assessment of dietary practice among diabetic patients in the United Arab Emirates. Rev Diabet Stud 2008;5(2):110-115.
30. Shamsi N, Shehab Z, Al Nahash Z, AlMuhanadi S, Al-Nasir F. Factors influencing dietary practice among type 2 diabetic. Bahrain Med Bull 2013;35(3):130-141.
31. Alkaabi JM, Al-Dabbagh B, Ahmad S, Saadi HF, Gariballa S, Ghazali MA. Glycemic indices of five varieties of dates in healthy and diabetic subjects. Nutr J 2011 May;10:59.
32. Freswick PN. Artificial Sweetened Beverages and Pediatric Obesity: The Controversy Continues. Children (Basel) 2014 May;1(1):31-39.
33. Al-Tawil NG, Abdulla MM, Abdul Ameer AJ. Prevalence of and factors associated with overweight and obesity among a group of Iraqi women. East Mediterr Health J 2007 Mar-Apr;13(2):420-429.
34. al-Isa AN. Dietary and socio-economic factors associated with obesity among Kuwaiti college men. Br J Nutr 1999 Nov;82(5):369-374.
35. Musaiger AO, Shahbeek NE, Al-Mannai M. The role of social factors and weight status in ideal body-shape preferences as perceived by Arab women. J Biosoc Sci 2004 Nov;36(6):699-707.
36. Musaiger AO, Qashqari K. The relation between dressing and obesity among women in Saudi Arabia. Arab J Food Nutrit 2005;6:292-302.
37. Nimeri A, Al Hadad M, Khoursheed M, Maasher A, Al Qahtani A, Al Shaban T, et al. The Peri-operative Bariatric Surgery Care in the Middle East Region. Obes Surg 2017 Jun;27(6):1543-1547.
38. Nimeri A, Mohamed A, El Hassan E, McKenna K, Turrin NP, Al Hadad M, et al. Are results of bariatric surgery different in the Middle East? Early experience of an international bariatric surgery program and an ACS NSQIP outcomes comparison. J Am Coll Surg 2013 Jun;216(6):1082-1088.
39. Abusnana S, Abdi S, Tagure B, Elbagir M, Maleckas A. Bariatric surgery outcomes: a single-center study in the United Arab Emirates. Diabetes Metab Syndr Obes 2015 Sep;8:461-471.
40. Hussain D, Naureen S, Ibrahim F, Javed SM, Abdel Aziz Z, Dillemans B. Initial experience with laparoscopic sleeve gastrectomy in Dubai hospital, United Arab Emirates. Saudi J Obes 2016;3(1):8-11.
41. Ernst B, Thurnheer M, Schmid SM, Schultes B. Evidence for the necessity to systematically assess micronutrient status prior to bariatric surgery. Obes Surg 2009 Jan;19(1):66-73.
42. Brown RJ, de Banate MA, Rother KI. Artificial sweeteners: a systematic review of metabolic effects in youth. Int J Pediatr Obes 2010 Aug;5(4):305-312.
43. Zelig R, Rigassio Radler D. Understanding the properties of common dietary supplements: clinical implications for healthcare practitioners. Nutr Clin Pract 2012 Dec;27(6):767-776.
44. Marik PE, Flemmer M. Do dietary supplements have beneficial health effects in industrialized nations: what is the evidence? JPEN J Parenter Enteral Nutr 2012 Mar;36(2):159-168.
45. Heindel JJ, Newbold R, Schug TT. Endocrine disruptors and obesity. Nat Rev Endocrinol 2015 Nov;11(11):653-661.
46. Diamanti-Kandarakis E, Bourguignon JP, Giudice LC, Hauser R, Prins GS, Soto AM, et al. Endocrine-disrupting chemicals: an Endocrine Society scientific statement. Endocr Rev 2009 Jun;30(4):293-342.
47. Fulco CE, Liverman CT, Sox HC, eds. Institute of Medicine (US) Committee on Health Effects Associated with Exposures During the Gulf War. Gulf war and health: Depleted uranium, pyridostigmine bromide, sarin, and vaccines. Washington (DC): National Academies Press (US); 2000.
48. Amin TT, Al-Sultan AI, Ali A. Overweight and obesity and their association with dietary habits, and sociodemographic characteristics among male primary school children in Al-Hassa, Kingdom of Saudi Arabia. Indian J Community Med 2008 Jul;33(3):172-181.
49. Al-Hazzaa HM, Al-Rasheedi AA. Adiposity and physical activity levels among preschool children in Jeddah, Saudi Arabia. Saudi Med J 2007 May;28(5):766-773.
50. Musaiger AO. Overweight and obesity in the Arab countries: the need for action. Arab Center for Nutrition: Bahrain; 2007.
51. Musaiger AO. The influence of television on children's habits. Bahrain Center for Studies and Research: Bahrain; 2004.
52. Mokdad AH. Burden of obesity in the Eastern Mediterranean Region: findings from the Global Burden of Disease 2015 study. Int J Public Health 2018 May;63(suppl):165-176.
53. Al-Qaoud N, Prakash P. Breastfeeding and obesity among Kuwaiti preschool children. Med Princ Pract 2009;18(2):111-117.
54. Beshyah SA, Hajjaji IM, Ibrahim WH, Deeb A, El-Ghul AM, Akkari KB, et al. The year in Ramadan fasting research (2017): A narrative review. Ibnosina J Med Biomed Sci 2018;10(2):39-53.
55. Rouhani MH, Azadbakht L. Is Ramadan fasting related to health outcomes? A review on the related evidence. J Res Med Sci 2014 Oct;19(10):987-992.
56. Beshyah SA. Fasting during the month of Ramadan for people with diabetes: Medicine and Fiqh united at last. Ibnosina J Med Biomed Sci. 2009;1:58-60.
57. Al-Quwaidhi AJ, Pearce MS, Critchley JA, Sobngwi E, O'Flaherty M. Trends and future projections of the prevalence of adult obesity in Saudi Arabia, 1992-2022. East

Mediterr Health J 2014 Oct;20(10):589-595.

58. Al-Quwaidhi AJ, Pearce MS, Sobngwi E, Critchley JA, O'Flaherty M. Comparison of type 2 diabetes prevalence estimates in Saudi Arabia from a validated Markov model against the International Diabetes Federation and other modelling studies. Diabetes Res Clin Pract 2014 Mar;103(3):496-503.
59. GCC Executive Plan Against Diabetes [cited 2017 August 23]. Available from: http://sgh.org.sa/Portals/0/PDF/Conventions/gcc_plane_DM.pdf.
60. Omar MS, Khudada K, Safarini S, Mehanna S, Nafach J. DiabCare survey of diabetes management and complications in the Gulf countries. Indian J Endocrinol Metab 2016 Mar-Apr;20(2):219-227.