

Alarming predictions for obesity and non-communicable diseases in the Middle East

Fanny Kilpi¹, Laura Webber^{1,*}, Abdulrahman Musaigner², Amina Aitsi-Selmi³, Tim Marsh¹, Ketevan Rtveladze¹, Klim McPherson⁴ and Martin Brown¹

¹National Heart Forum, 7th Floor Victoria House, London WC1B 4AD, UK; ²Nutrition and Health Studies Unit, Deanship of Scientific Research, University of Bahrain, Manama, Bahrain; ³Epidemiology & Public Health, Division of Population Health, University College London, London, UK; ⁴New College, Oxford, UK

Submitted 13 August 2012; Final revision received 28 January 2013; Accepted 5 February 2013; First published online 3 May 2013

Abstract

Objective: The present study aimed to model obesity trends and future obesity-related disease for nine countries in the Middle East; in addition, to explore how hypothetical reductions in population obesity levels could ameliorate anticipated disease burdens.

Design: A regression analysis of cross-sectional data *v.* BMI showed age- and sex-specific BMI trends, which fed into a micro simulation with a million Monte Carlo trials for each country. We also examined two alternative scenarios where population BMI was reduced by 1% and 5%.

Setting: Statistical modelling of obesity trends was carried out in nine Middle East countries (Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia and Turkey).

Subjects: BMI data along with disease incidence, mortality and survival data from national and sub-national data sets were used for the modelling process.

Results: High rates of overweight and obesity increased in both men and women in most countries. The burden of incident type 2 diabetes, CHD and stroke would be moderated with even small reductions in obesity levels.

Conclusions: Obesity is a growing problem in the Middle East which requires government action on the primary prevention of obesity. The present results are important for policy makers to know the effectiveness of obesity interventions on future disease burden.

Keywords
Obesity trends
Middle East and North Africa
Modelling
Non-communicable disease

Non-communicable diseases (NCD) are the major cause of morbidity and mortality in most countries of the Middle East, representing more than 60% of total annual deaths^(1,2). Currently 80% of deaths from NCD are in developing countries, indicating that NCD are not simply diseases of developed countries. The first global ministerial conference on healthy lifestyles and NCD control in Moscow, in April 2011, led to the Moscow Declaration calling for the global health community to address the seriousness and growing problem of NCD⁽³⁾. It also identified actions to address obesity and NCD at the whole-of-government level by ministries of health in countries. Further, the UN high level meeting in September 2011 resulted in the adoption of a political declaration to address the global burden of NCD⁽⁴⁾. Both of these meetings have greatly increased the profile of NCD and the importance of governments taking NCD into account during long-term health planning.

It is well documented that obesity is a key risk factor for NCD, particularly type 2 diabetes, CVD, osteoarthritis and some types of cancer. Across the Middle Eastern region

the prevalence of obesity ranks among the highest in the world. A recent review reported that the prevalence of overweight and obesity among adults ranged from 50 to 80%, with higher prevalence among women than men⁽¹⁾.

One study covering fifty-two countries from eight geographical regions worldwide showed that adult men and women in the Middle East have the highest mean BMI after the USA⁽²⁾. Additionally, the women in this region have the highest waist-to-hip ratio compared with all other regions⁽²⁾ and similar results were reported by the Chronic Disease Collaborating Group in a study covering 199 countries⁽⁵⁾. Although the Middle Eastern region is characterized by different socio-economic levels, the prevalence in high-income countries (such as Arab Gulf states) and middle-income countries (such as Iran, Egypt, Jordan and Lebanon) was very similar, indicating that cultural rather than economic factors determine obesity in this region⁽⁶⁾. Further, costly energy subsidies of food and fuel are widespread in the region. In 2011, these were estimated to cost \$US 212 billion (7.2% of Gross Domestic Product)⁽⁷⁾. These subsidies are

*Corresponding author: Email laura.webber@heartforum.org.uk

likely to promote the consumption of highly energy-dense foods as well as the use of mechanized transport⁽⁸⁾.

Higher availability and consumption of highly energy-dense foods (the nutrition transition) in conjunction with epidemiological transition (rapid population growth with modernization and advances in medicine improving fertility and reducing mortality) has led to considerable changes in dietary habits and lifestyle of the populations of this region. Shifts to more westernized diets, characterized by high fat, sugar and salt, have been apparent. Low intakes of fruit, vegetables and complex carbohydrates have been reported in all countries in the Middle Eastern region⁽¹⁾. Large-scale urbanization, labour market changes from manual work to office work and increasingly sedentary lifestyles have led to marked decreases in physical activity. These changes, as well as other socio-economic factors, have contributed to the high prevalence of obesity and its co-morbidities in the Middle East^(1,9,10).

Despite the recognition of obesity as a significant worldwide problem, in-depth analysis of population trends in obesity and its consequences are lacking in both developed and developing countries⁽¹⁾. Therefore, the present study aimed to model the effects of obesity in the population and predict the potential impact of raised BMI on future disease burden. While forecasts can only be predictive and not absolute, they are vital if countries are to adequately prepare for a tide of NCD morbidity and mortality. Micro simulation modelling was used to examine the effect of interventions that successfully reduce population BMI on future disease burden, extending current knowledge of the obesity epidemic in the Middle Eastern region.

Methods

Search strategy

A review of studies including data on BMI and obesity for the adult population in the Middle Eastern region between 1990 and 2010 was carried out using PubMed and Google Scholar search engines. Annex 1 (Supplementary Materials) provides specific details of the search strategy. The WHO BMI global database⁽¹¹⁾ and hand-searches of article reference lists were also used in the review. The inclusion criteria were: (i) availability of data on BMI and obesity by age and sex and (ii) representative adult population (i.e. not specific groups). Data on children and adolescents were excluded because of lack of data and where data exist, the use of several reference standards for defining overweight and obesity made the findings hard to compare. Studies based on self-reported BMI and those with a non-representative sample of the general population such as data on a specific group were also excluded. Nevertheless, some sub-national studies represented urban populations only and were included because of the lack of sufficient numbers of national studies in these countries. The common BMI

cut-offs recommended by WHO for defining overweight (BMI = 25.0–29.9 kg/m²) and obesity (BMI ≥ 30.0 kg/m²) were used. Table 1 provides the references and study details of each BMI data point included for each country.

With a second literature review we looked for age- and sex-specific data on the incidence, survival and mortality from ten obesity-related diseases in the Middle East (CHD, stroke, type 2 diabetes, and breast, colorectal, pancreatic, oesophageal, endometrial, liver and kidney cancer). Keyword searches through PubMed revealed that the required disease data were not available for most of the countries under study, so in several cases we used the best available data from the region and applied it with some adjustments to the other countries. For fatal diseases, a proxy country's incidence data were adjusted using a known, target country's mortality rate: the ratio of the target-to-proxy countries' mortality rates was used to scale the proxy country's incidence rates. For non-fatal diseases, proxy country data were adjusted for the different population BMI distributions. CHD and stroke incidence data were available only for Iran (personal communication from M Talaei, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Science, May 2011). For all other countries CHD incidence data for Iran were used but were adjusted by the ratios of country-specific age-standardized CHD and stroke mortality rates. Stroke incidence from Iran⁽¹²⁾ was similarly adjusted by stroke mortality rate ratios. The only study of type 2 diabetes incidence found for the region was also from Iran⁽¹³⁾. To use it for the other countries, diabetes incidence was adjusted by the country-specific obesity rates, as the disease is treated as non-terminal in the analysis. For cancer, incidence and mortality data for each country were extracted from GLOBOCAN⁽¹⁴⁾. For each disease, one set of survival data for the terminal disease was collected from the best available studies in the region due to the scarcity of country-specific studies. Annex 2 (Supplementary Materials) provides the references of each disease for each country.

The obesity-related relative risks for each disease were obtained from a review conducted by the DYNAMO-HIA (DYNAMIC MOdel for Health Impact Assessment) report on data collection for overweight and obesity prevalence and related relative risks⁽¹⁵⁾.

Statistical analysis

A two-step modelling process was developed by Foresight⁽¹⁶⁾ and has been used for analysis of obesity in the UK and USA⁽¹⁷⁾, Eastern Europe⁽¹⁸⁾ and Latin America⁽¹⁹⁾. The same method was applied in the present study. In module 1 the data were fitted with non-linear, multi-variate, categorical regression models with outliers removed, revealing the age- and sex-specific obesity trends. For each country at least two time points of data were necessary. The results were fed into a micro simulation program (module 2), which produces longitudinal

Table 1 References of BMI data used for projecting obesity trends

Country	Data source/citation	Data year(s)	Sample size		Age group (years)	Measured/self-reported	National/regional data
			M	F			
Bahrain	Musaiger and Al-Mannai ⁽³¹⁾	1992	298	216	30–79	Measured	National
	Al-Mahroos and Al-Roomi ⁽³²⁾	1995–1996	1168	845	M:40–59, F:50–69	Measured	National
	National Nutrition Survey 2002/Ministry of Health ⁽³³⁾	1998–1999	1120	1181	19–100	Measured	National
Egypt	STEPS/Ministry of Health ⁽³⁴⁾	2007	854	858	20–64	Measured	National
	STEPS/Ellabanny and Abdel-Nasser ⁽³⁵⁾	2005	4993	4787	15–65	Measured	National
	DHS/El-Zanaty and Way ⁽³⁶⁾	2008	5573	5685	15–59	Measured	National
Iran	Sarrafi-Zadegan <i>et al.</i> ⁽³⁷⁾	1994	1000	1200	19–70	Measured	Sub-national (urban)
	Tehran Lipid and Glucose Study/HosseiniPanah <i>et al.</i> ⁽³⁸⁾	1999–2001	1835	2567	20–100	Measured	Sub-national (urban)
	Hajian-Tilaki and Heidari ⁽³⁹⁾	2004	1800	1800	20–70	Measured	Sub-national (urban)
	STEPS/Ministry of Health & Medical Education ⁽⁴⁰⁾	2005	45082	44322	15–64	Measured	National
	Rashidy-Pour <i>et al.</i> ⁽⁴¹⁾	2005–06	1695	2104	30–70	Measured	Sub-national (urban/rural)
	STEPS/Ministry of Health & Medical Education ⁽⁴²⁾	2007	14830	14517	15–64	Measured	National
	STEPS/Ministry of Health & Medical Education ⁽⁴³⁾	2008	14678	14254	15–64	Measured	National
Jordan	STEPS/Ministry of Health & Medical Education ⁽⁴⁴⁾	2009			15–64	Measured	National
	Ajlouni <i>et al.</i> ⁽⁴⁵⁾	1994–1996	1046	1790		Measured	Sub-national (semi-urban)
	Khader <i>et al.</i> ⁽⁴⁶⁾	2004	394	727		Measured	Sub-national
Kuwait	Al-Isa ⁽⁴⁷⁾	1980–1981	896	1171	18–100	Measured	Sub-national (urban)
	Al-Isa ⁽⁴⁷⁾	1993–1994	1730	1705	18–100	Measured	Sub-national (urban)
	Kuwait Nutrition Surveillance System 2004/Ministry of Health ⁽⁴⁸⁾	2004	1226	1778	20–100	Both	National
Lebanon	STEPS/Al-Nesf <i>et al.</i> ⁽⁴⁹⁾	2006	905	1277	20–64	Measured	National
	Sibai <i>et al.</i> ⁽⁵⁰⁾	1997	501	715	20–100	Measured	National
Oman	STEPS/Sibai and Hwalla ⁽⁵¹⁾	2008–2009	883	1070	25–64	Measured	National
	National Diabetes Survey/Al-Lawati and Jousilahti ⁽⁵²⁾	1991	2128	2958	20–100	Measured	National
	National Health Survey/Al-Lawati and Jousilahti ⁽⁵²⁾	2000	3069	3331	20–100	Measured	National
Saudi Arabia	STEPS/Al Farsi <i>et al.</i> ⁽⁵³⁾	2006	599	774	20–100	Measured	Sub-national (urban/rural)
	Al-Nozha <i>et al.</i> ⁽⁵⁴⁾	1987–1992	2625	3585	18–100	Measured	National
	Ministry of Health Saudi Arabia ⁽⁵⁵⁾	1990–1993	5407	5244	20–100	Measured	National
	CADISS National Epidemiological Health Survey/Al-Nozha <i>et al.</i> ⁽⁵⁴⁾	1995–2000	8215	9008	30–70	Measured	National
Turkey	STEPS/Al-Hamdan <i>et al.</i> ⁽⁵⁶⁾	2004–2005	2244	2345	15–64	Measured	National
	Erem <i>et al.</i> ⁽⁵⁷⁾	1998/99	1324	1322	20–100	Measured	Sub-national (urban)
	Turkish Obesity and Hypertension Study/Hatemi <i>et al.</i> ⁽⁵⁸⁾	1999–2000	15144	4975	21–100	Measured	Sub-national (urban)
	Yumuk <i>et al.</i> ⁽⁵⁹⁾	2001	5866	7000	20–100	Measured	Sub-national (urban/rural)
	Erem <i>et al.</i> ⁽⁶⁰⁾	2001–2002	2288	2728	20–69	Measured	Subnational (urban)
	Oğuz <i>et al.</i> ⁽⁶¹⁾	2004–2005	2110	2154	20–100	Measured	National
	Iseri and Arslan ⁽⁶²⁾	2007	2263	1942	20–85	Measured	National

M, males; F, females; STEPS, STEPwise approach to Surveillance; DHS, Demographic and Health Survey; CADISS, Coronary Artery Disease in Saudis Study.

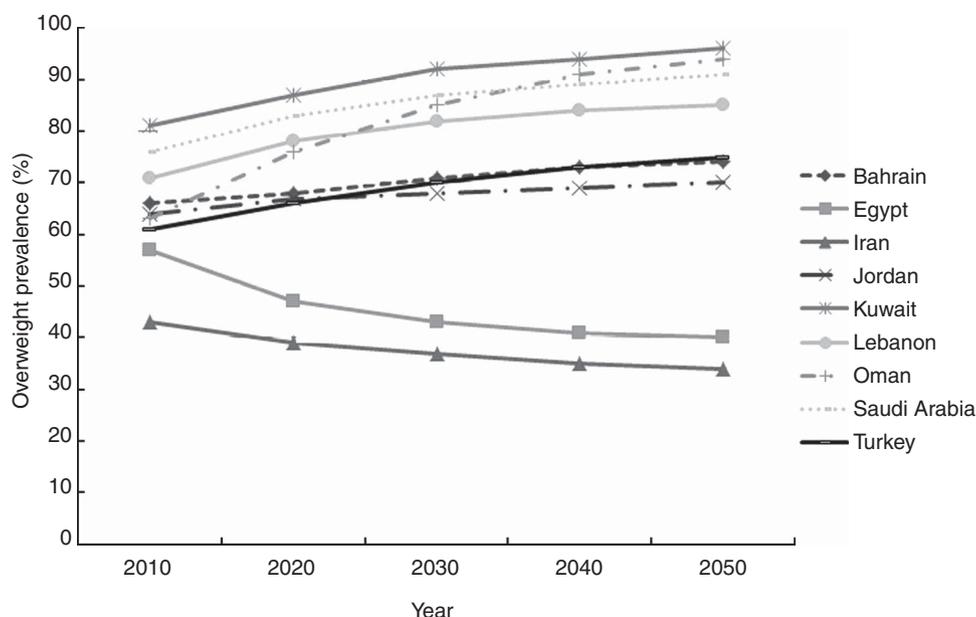


Fig. 1 Longitudinal projections of overweight prevalence ($\text{BMI} \geq 25.0 \text{ kg/m}^2$) in men in the Middle East using multivariate non-linear regression

projections of the associated burden of disease. The Monte Carlo method was used to create a cohort of individuals (here set to one million for each country), which has the demographic characteristics determined by population data from UN and WHO statistics for each country. For each individual in the cohort, a BMI value gets probabilistically assigned as a function of age, sex and calendar year. The individuals of the cohort proceed through the simulation with BMI, age and sex determining their risk of getting any of the ten diseases. Relative risks of disease due to obesity are included in the model. A comprehensive description of the micro simulation method can be found in Annex 3 (Supplementary Materials). The micro simulation was repeated for each country with two alternative scenarios of obesity trends. In comparison with the baseline assumption of unchecked obesity trends, we examined the effect of 1% and 5% reductions in population BMI across the region.

Results

From the databases and articles searched, thirty-five data points for BMI were suitable for inclusion. Nine countries had two or more years of appropriate data (Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia and Turkey). Egypt, Jordan and Lebanon only had two years of data, and for Jordan they were both from urban samples. A combination of sub-national and national data was used for trends in Iran, Kuwait, Oman and Turkey. Israel, Morocco, Tunisia and the United Arab Emirates were not included as not enough suitable data were available at the time of analyses. According to these

studies the highest levels of obesity to begin with were in Kuwait. Obesity was least pronounced in Iran, with a decrease over time observed in men. Annex 4 (Supplementary Materials) presents the current prevalence of obesity and projected trends in each country based on past and present data.

Figures 1 and 2 show the trends for combined overweight and obesity ($\text{BMI} \geq 25.0 \text{ kg/m}^2$) prevalence (termed 'overweight') for men and women of all ages in each country. Kuwaiti men and women come out on top; overweight and obesity reaches exceedingly high levels in both men and women by 2030. Saudi Arabian men and women also have consistently high levels of overweight, but the expected increase in overweight appears particularly steep for men in Oman. Bahrain and Jordan all have high levels of overweight, with moderate increases over time. The data for Egypt, on the other hand, suggest decreasing overweight for both men and women. Decreases are also shown for men in Iran, which in general seems to have one of the lowest levels of overweight for men and women of the nine countries. Nevertheless, for Iranian women the proportion with $\text{BMI} \geq 25.0 \text{ kg/m}^2$ is still more than half of the female population and set to stay that way. A slight decrease in overweight was also observed for Turkish women.

Figure 3 shows the extent of disease cases avoided if population-level BMI was to decrease by even a small percentage. In scenario 1, a 1% reduction in obesity leads to a considerable amount of disease cases avoided in all countries. For example, in Bahrain, Kuwait, Lebanon, Oman and Saudi Arabia, by 2030 over a thousand cases of diabetes are avoided per 100 000 of the population. A substantial number of CHD and stroke cases are also

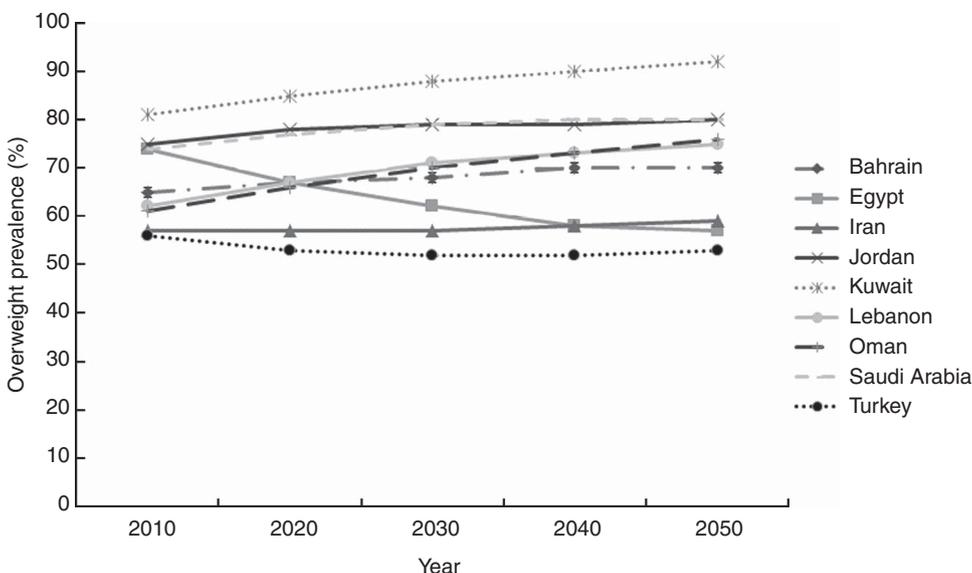


Fig. 2 Longitudinal projections of overweight prevalence (BMI ≥ 25.0 kg/m²) in women in the Middle East using multivariate non-linear regression

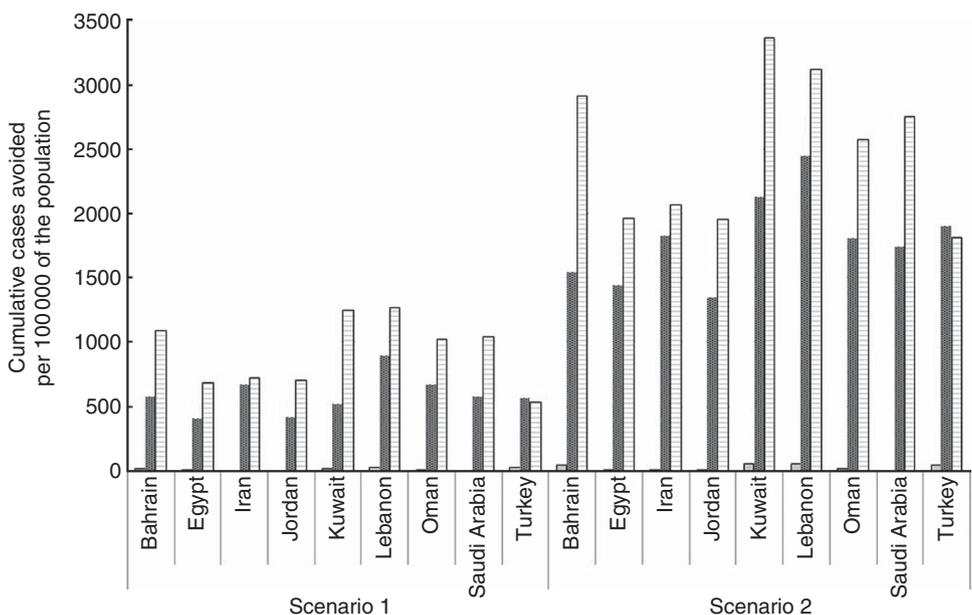


Fig. 3 Cumulative incidence cases of obesity-related non-communicable diseases (□, cancers; ▨, CHD and stroke; ▩, diabetes) avoided in Middle Eastern countries (per 100 000 population in 2010) by 2030, estimated using micro simulation modelling. Note: scenario 1 refers to a 1% decrease in population BMI; scenario 2 refers to a 5% decrease in population BMI

prevented in this scenario, particularly in Lebanon, Oman and Iran. Cancer rates do not reach levels where a 1% obesity reduction would have a noticeable effect. Incidence, mortality and survival data for each country are referenced in Annex 5 (Supplementary Materials).

If a 5% reduction in population BMI is achieved as per scenario 2, the number of CHD, strokes and diabetes cases prevented becomes even higher. The number of CHD and stroke cases avoided ranges from 1400 to 2500 (per 100 000 population in 2010) for these Middle Eastern

countries, with the highest numbers in Lebanon. However, the numbers of cancer cases avoided are still modest for all countries.

Based on the total population in Kuwait in 2010⁽²⁰⁾, 1032, 39 905 and 63 217 incidence cases of cancer, CHD and stroke, and type 2 diabetes, respectively, will be avoided given a 5% decrease in obesity. Based on the total population in Saudi Arabia in 2010⁽²⁰⁾, over 115 000 cases of CHD and stroke and over 200 000 cases of type 2 diabetes will be avoided with a 1% decrease in obesity

by 2030, whereas with a successful intervention to reduce obesity by 5%, 350 000 cases of CHD and stroke and 550 000 cases of type 2 diabetes could be avoided by 2030. A reduction in obesity will have less effect upon avoided cancer incidence in the total population.

Discussion

The latest national data from the Middle East reveal worryingly high obesity rates in many countries and the projections from the present analysis demonstrate how the obesity epidemic is not abating. In particular, our results for Kuwait, Oman, Saudi Arabia, Lebanon, Turkey, Bahrain and Jordan show that the problem of obesity is growing. Given that obesity is a risk factor for many NCD, this has major implications for the public health systems of these countries. The present study builds on past research by Finucane *et al.*⁽⁵⁾ by estimating future trends and testing the impact of effective interventions.

Life expectancy is expected to increase remarkably during the coming four decades in the Middle Eastern region. The regional average percentage of life expectancy increase will be 15% from 2000–2005 to 2045–2050, ranging from 5.8% to 25.7%⁽²¹⁾. Most if not all Middle Eastern countries will experience an increase in ageing populations, but the extent of the demographic transition varies. According to UN Population Reference Bureau data available online (<http://www.un.org/esa/population/>), Turkey and Lebanon have the highest proportions of people over the age of 65 years in the region, reaching 7%, and fertility is below replacement level in Iran (1.74) and Lebanon (1.85). Age-specific trends indicate rapid increases in obesity in middle-aged or older adults and a sharp increase in ageing and NCD. Young adults in most countries do not show very steep obesity trends (Annex 6, Supplementary Materials). The ageing population combined with the BMI trends in older adults therefore represent a growing public health concern (Annex 6, Supplementary Materials presents the population distribution of each country).

It is unclear why Egypt and Iran show decreasing trends in overweight and obesity. It is possible that the mix of early sub-national and later national data in Iran biased the trends observed. Detailed BMI trends can be difficult to ascertain when the quality of the data is poor. Particularly the data for older adults were based on very limited samples or were non-existent. Moreover, analysis with just two data points gives only indicative results. Some studies did not have samples representative of the national population. Regional studies often have urban samples, which usually have higher relative BMI rates than would be found in a rural population. In countries such as Iran, with a large and diverse society, regional studies do not tell the whole picture and may also somewhat distort trends.

Furthermore, for a more complete picture of population health, the simulation would also need to incorporate the trends for children. Obesity is highly prevalent among children and adolescents in this region (excluding low-income countries), where the prevalence of overweight and obesity ranges from 20 to 45%⁽¹⁾. Including the young population in projections of future NCD rates would likely further increase the estimated size of the epidemic levels of morbidity and mortality. However, it was not possible to analyse the trends in children and adolescents due to lack of applicable data.

The increase of obesity during the past two decades in the Middle East has paralleled rises in diabetes, CVD and cancer. For example, the prevalence of diabetes in Jordan increased by 31.5% during 1994–2006⁽²²⁾. It was reported that five countries in the region were among the ten countries with the world's highest diabetes rates, namely Bahrain, Kuwait, Oman, Saudi Arabia and the United Arab Emirates. The Middle East has been projected to experience one of the highest relative increases in the burden of diabetes in the world by 2030⁽²³⁾. A systematic review on stroke in Arab countries showed that the annual stroke increase ranged from 27.5 to 63 per 100 000 population. Ischaemic stroke was the most common subtype of all series. Hypertension, diabetes, hyperlipidaemia and cardiac diseases were the main risk factors⁽²⁴⁾. In Iran, it was found that the annual stroke incidence in various age groups ranged from 23 to 103 per 100 000 population⁽²⁵⁾. Several types of cancer are linked with obesity such as breast and colon cancers. These cancers are highly prevalent in most countries of the Middle East and cancer ranks as the fourth leading cause of death. The WHO reported that the highest increase in cancer incidence among WHO regions in the next 15 years is likely to be in the Middle East⁽²⁵⁾.

The rapid change in food habits and lifestyle plays an important role in the high prevalence of obesity in the Middle East. During 1971–2005, FAO reported that there was an increase in per capita energy intake in all countries in the region. In this period, the percentage of energy which came from animal foods increased markedly⁽²⁶⁾. The high intakes of fast foods and sugar-sweetened beverages have continued to rise as has the frequency of eating outside the home across the region, especially in high-income countries such as Arab Gulf states. A sedentary lifestyle and lack of physical activity were reported in most countries in the Middle East⁽²⁷⁾. In Saudi Arabia, for example, the prevalence of inactivity among adults reached 96%⁽²⁸⁾. However, the aetiology may be complicated by interaction between socio-cultural factors and lifestyle factors. Women, for example, might be experiencing conflicts of body image. Women have also been suggested to face greater barriers to practising physical activity than men, who in general have more freedom and places to exercise and participate in other recreational activities than women⁽²⁾. The comparatively

higher rates seen in the Middle Eastern countries compared with Asia may be partly related to cultural factors that limit women's mobility. Other explanations include the existence of subsidies for energy-dense foods. The subsidization of wheat flour, rice, oils and sugar in many countries in the region may increase their intake, leading to higher consumption of energy. For example, in Egypt subsidized foods account for over 30% of the overall per capita energy availability⁽²⁶⁾.

Reducing obesity is an important strategy for lessening the future burden of disease. The simulation method is ideal for testing the effect of any scenario. It is possible to examine the consequence of any intervention with a known effect on BMI in a specific subset of the population. We modelled two scenarios of moderate reductions in obesity across the whole population. Considerable numbers of diabetes and of CHD and stroke cases were prevented in both scenarios for all countries. Of course the further the obesity problem has reached, the more critical the interventions become. Unchecked obesity trends are our best guess of how the epidemic will proceed without intervention. Undeniably, critical circumstances may change, for example food availability and prices. Even the political unrest of the Arab Spring may prove to have far-reaching consequences on lifestyles and health. Despite this, forecasts are necessary in planning the allocation of future resources for health.

The greatest limitation to our analysis is the paucity of the BMI and disease data available from each country, highlighting the need for improving systems of health surveillance. We were unable to include some countries such as the United Arab Emirates and Morocco since there were no suitable data available in the format necessary for the model. In addition, disease data were absent from many countries so we often had to make assumptions and often extrapolate from other countries in the region. Less robust conclusions can be drawn regarding the direction and speed of change in obesity where only a few (three or less) years of data were available; however, the exercise is still important since it emphasizes the necessity of population surveillance in health. Furthermore, the model now exists and can easily be updated when new data are made available. Good-quality national data on diseases can inform policy as well as facilitate international comparisons.

Further analyses might incorporate data on the social determinants of health including education level and asset-based wealth to take into account the dynamic relationship between socio-economic status (SES) and excess weight. There is strong evidence that as economic transition occurs, the burden of obesity shifts down the socio-economic gradient⁽⁶⁾. This pattern is observed earlier among women compared with men, particularly along the education gradient, such that women with low education experience a rapidly increasing obesity risk. The SES-excess weight associations will modify risk

estimates for obesity-related diseases by age and gender depending on how wealth and education are distributed in these groups. Recent analyses of Egyptian national data show different SES-obesity associations by SES indicator⁽²⁹⁾. An accurate understanding of how the social distribution of excess weight changes over time will aid in interpreting the results of further micro simulations and is essential in devising any intervention strategies in order to address the appropriate risk factors and target the vulnerable groups.

The UN high-level summit in September 2011 enabled the opportunity for global action against NCD. The Lancet NCD action group proposed five priority actions for the response to the NCD crisis: leadership, prevention, treatment, international cooperation, and monitoring and accountability. These actions, the NCD action group proposed, should be made on five priority interventions which include tobacco control, improved diets and physical activity, alcohol intake, essential drugs and technologies, and salt reduction⁽³⁰⁾.

Conclusion

The obesity epidemic has the Middle East in its grip, bringing along a tide of chronic disease that will severely affect population well-being and test national health systems. People and resources need to be mobilized to manage the burdens of disease that may be expected with the current obesity trends. Exploring different BMI scenarios with the micro simulation method shows how even modest reductions in obesity prevent illness and lessen the health-care burden.

Acknowledgements

Source of funding: This study was funded by an unconditional educational grant from GlaxoSmithKline (grant number 27875780). *Ethics:* Ethical approval was not required. *Conflicts of interest:* There are no conflicts of interest to declare. *Authors' contribution:* F.K. and L.W. made a substantial contribution to the literature search, data collection, analysis and interpretation of the data, drafting and editing of the article, preparing the article for submission and approval of the final version. A.M. and A.A.-S. made a substantial contribution to the drafting and revising of the manuscript for important intellectual content and gave approval for the final version to be published. K.R. made a substantial contribution to the literature search, analysis and interpretation of the data, drafting and redrafting the article and approval of the final version. M.B. made a substantial contribution to the analysis, conception and design of the study, interpretation of the data, revising the article critically for important intellectual content and approval of the final version. T.M. and K.M. made a substantial contribution to conception

and design of the study, acquisition of the data, revising the article critically for intellectual content and approval of the final version.

Supplementary Materials

To view supplementary materials for this article, please visit <http://dx.doi.org/10.1017/S1368980013000840>

References

- Musaiger AO (2011) Overweight and obesity in the Eastern Mediterranean: prevalence and possible causes. *J Obes* **2011**, 407237.
- Yusuf S, Hawken S, Ounpuu S *et al.* (2005) Obesity and the risk of myocardial infarction in 27 000 participants from 52 countries: a case-control study. *Lancet* **66**, 1640–1649.
- World Health Organization (2013) First Global Ministerial Conference on Healthy Lifestyles and NCD Control, 28–29 April 2011, Moscow, Russian Federation. <http://www.euro.who.int/en/what-we-do/event/first-global-ministerial-conference-on-healthy-lifestyles-and-ncd-control> (accessed February 2013).
- United Nations (2013) 2011 UN High Level Meeting on Prevention and Control of Non-communicable Diseases, New York, 19–20 September 2011. <http://www.un.org/en/ga/ncdmeeting2011/> (accessed March 2013).
- Finucane MM, Stevens GA, Cowan MJ *et al.* (2011) National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 91 million participants. *Lancet* **377**, 557–567.
- Monteiro CA, Moura EC, Conde WL *et al.* (2004) Socio-economic status and obesity in adult populations of developing countries: a review. *Bull World Health Organ* **82**, 940–946.
- International Monetary Fund (2012) Costly Mideast Subsidies Need Better Targeting. <http://www.imf.org/external/pubs/ft/survey/so/2012/car051412b.htm> (accessed November 2012).
- Asfaw A (2007) Do government food price policies affect the prevalence of obesity? Empirical evidence from Egypt. *World Dev* **35**, 687–701.
- Ghassemi H, Harrison G & Mohammad K (2002) An accelerated nutrition transition in Iran. *Public Health Nutr* **5**, 149–155.
- Galal OM (2002) The nutrition transition in Egypt: obesity, undernutrition and the food consumption context. *Public Health Nutr* **5**, 141–148.
- World Health Organization (2011) Global Database on Body Mass Index. <http://apps.who.int/bmi/index.jsp> (accessed March 2011).
- Azarpazhooh MR, Etemadi MM, Donnan GA *et al.* (2010) Excessive incidence of stroke in Iran: evidence from the Mashhad Stroke Incidence Study (MSIS), a population-based study of stroke in the Middle East. *Stroke* **41**, e3–e10.
- Harati H, Hadaegh F, Saadat N *et al.* (2009) Population-based incidence of type 2 diabetes and its associated risk factors: results from a six-year cohort study in Iran. *BMC Public Health* **9**, 186.
- International Agency for Research on Cancer (2011) The GLOBOCAN Project. <http://globocan.iarc.fr/> (accessed August 2011).
- European Commission (2010) Dynamo-HIA, WP-10 on cancer, Report on Data Collection, Public Health and Risk Assessment. http://www.dynamo-hia.eu/object_binary/o3054_Cancer_WP10_datareport_20100_104.pdf (accessed March 2013).
- McPherson K, Marsh T & Brown M (2007) *Tackling Obesities: Future Choices – Modelling Future Trends in Obesity and Their Impact on Health. Report for Foresight*. London: Government Office of the Chief Scientist.
- Wang C, McPherson K, Marsh T *et al.* (2011) Health and economic burden of projected obesity trends in the USA and the UK. *Lancet* **378**, 815–825.
- Webber L, Kilpi F, Marsh T *et al.* (2012) Modelling obesity trends and related diseases in Eastern Europe. *Obes Rev* **13**, 744–751.
- Webber L, Kilpi F, Marsh T *et al.* (2012) High rates of obesity and non-communicable diseases predicted across Latin America. *PLoS One* **7**, e39589.
- United Nations (2010) *World Population Prospects, 2010 Edition*. New York: UN, Department of Economic and Social Affairs; available at <http://esa.un.org/wpp/other-information/faq.htm>
- World Health Organization, Regional Office for the Eastern Mediterranean (2006) *Active Aging and Promotion of the Health of the Older People*. Cairo: WHO Regional Office for the Eastern Mediterranean.
- Ajlouni K, Khader YS, Batiha A *et al.* (2008) An increase in prevalence of diabetes mellitus in Jordan over 10 years. *J Diabetes Complications* **22**, 317–324.
- Shaw JE, Sicree RA & Zimmet PZ (2010) Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract* **87**, 4–14.
- Benamer HT & Grosset D (2009) Stroke in Arab countries: systematic literature review. *J Neurol Sci* **15**, 18–23.
- World Health Organization, Regional Office for the Eastern Mediterranean (2009) Towards a strategy for cancer control in the Eastern Mediterranean region. <http://www.emro.who.int/dsaf/dsa1002.pdf> (accessed January 2012).
- Food and Agriculture Organization of the United Nations (2012) FAOSTAT food balance sheets. <http://faostat.fao.org/> (accessed January 2012).
- Musaiger AO, Hassan AS & Obeid O (2011) The paradox of nutrition-related diseases in the Arab countries: the need for action. *Int J Environ Res Public Health* **8**, 3637–3671.
- Al-Nozha M, Al-Hazzaa H, Arafah MR *et al.* (2007) Physical activity and inactivity among Saudi aged 30–70 years: a population-based cross-sectional study. *Saudi Med J* **28**, 559–568.
- Aitsi-Selmi A, Chandola T, Friel S *et al.* (2012) Interaction between education and household wealth on the risk of obesity in women in Egypt. *PLoS One* **7**, e39507.
- Beaglehole R, Bonita R, Horton R *et al.* (2011) Priority actions for the non-communicable disease crisis. *Lancet* **377**, 1438–1447.
- Musaiger AO & Al-Mannai MA (2001) Weight, height, body mass index and prevalence of obesity among the adult population in Bahrain. *Ann Hum Biol* **28**, 346–350.
- Al-Mahroos F & Al-Roomi K (2001) Obesity among adult Bahraini population: impact of physical activity and educational level. *Ann Saudi Med* **21**, 183–187.
- Anon (2002) *National Nutrition Survey for Adult Bahrainis Aged 19 Years and Above*. Kingdom of Bahrain: Ministry of Health.
- Anon (2009) *National Non-communicable Diseases Risk Factors Survey 2007 (STEPS)*. Kingdom of Bahrain: Ministry of Health.
- Ellabany E & Abel-Nasser MA (2006) *Community Based Survey Study on Non-Communicable Diseases and Their Risk Factors, Egypt, 2005–2006 (STEPS)*. Egypt: MoH Egypt.
- El-Zanaty F & Way A (2009) *Egypt Demographic and Health Survey 2008*. Cairo: Ministry of Health, El-Zanaty and Associates, and Macro International.
- Sarraf-Zadegan N, Boshtam M & Rafiei M (1999) Risk factors for coronary artery disease in Isfahan, Iran. *Eur J Public Health* **9**, 20–26.

38. Hosseinpanah F, Barzin M, Eskandary PS *et al.* (2009) Trends of obesity and abdominal obesity in Teheranian adults: a cohort study. *BMC Public Health* **9**, 426.
39. Hajian-Tilaki KO & Heidari B (2007) Prevalence of obesity, central obesity and the associated factors in urban population aged 20–70 years, in the north of Iran: a population-based study and regression approach. *Obes Rev* **8**, 3–10.
40. Islamic Republic of Iran, Ministry of Health & Medical Education (2005) Non-Communicable Disease Risk Factor InfoBase. STEPS 2005. http://www.who.int/chp/steps/IR_Iran STEPSReport.pdf (accessed March 2011).
41. Rashidy-Pour A, Malek M, Eskandarian R *et al.* (2009) Obesity in the Iranian population. *Obes Rev* **10**, 2–6.
42. Islamic Republic of Iran, Ministry of Health & Medical Education (2007) Non-Communicable Disease Risk Factor InfoBase. STEPS 2007. <http://www.ncdinfobase.ir/english/docs.asp> (accessed March 2011).
43. Islamic Republic of Iran, Ministry of Health & Medical Education (2009) Non-Communicable Disease Risk Factor InfoBase. STEPS 2008. <http://www.ncdinfobase.ir/english/docs.asp> (accessed March 2011).
44. Islamic Republic of Iran, Ministry of Health & Medical Education (2010) Non-Communicable Disease Risk Factor InfoBase. STEPS 2009. <http://www.ncdinfobase.ir/english/docs.asp> (accessed March 2011).
45. Ajlouni K, Jaddou H & Batiha A (1998) Obesity in Jordan. *Int J Obes Relat Metab Disord* **22**, 624–628.
46. Khader Y, Batiha A, Ajlouni H *et al.* (2008) Obesity in Jordan: prevalence, associated factors, comorbidities, and change in prevalence over ten years. *Metab Syndr Relat Disord* **6**, 113–120.
47. Al-Isa AN (1997) Changes in body mass index (BMI) and prevalence of obesity among Kuwaitis 1980–1994. *Int J Obes Relat Metab Disord* **21**, 1093–1099.
48. Ministry of Health (2004) *Kuwait Nutrition Surveillance System, Jan–Dec 2004*. Kuwait: MoH Kuwait.
49. Al-Nesf Y, Kamel MI, Makboul GM *et al.* (2006) *Risk Factors of Non Communicable Diseases in the State of Kuwait (STEPS 2006)*. Kuwait: MoH; available at http://www.who.int/chp/steps/STEPS_Report_Kuwait.pdf
50. Sibai AM, Hwalla N, Adra N *et al.* (2003) Prevalence and covariates of obesity in Lebanon: findings from the first epidemiological study. *Obes Res* **11**, 1353–1361.
51. Sibai AM & Hwalla N (2010) *WHO STEPS Chronic Disease Risk Factor Surveillance: Data Book for Lebanon, 2009*. Lebanon: American University of Beirut; available at http://www.who.int/chp/steps/2008_STEPS_Lebanon.pdf
52. Al-Lawati JA & Jousilahti PJ (2004) Prevalence and 10-year secular trend of obesity in Oman. *Saudi Med J* **25**, 346–351.
53. Al Farsi M, El Melighy M, Mohames S *et al.* (2006) Sur Healthy City Project – Healthy Life Style Study – Assessment of life style risk factors among Sur city population. http://www.who.int/chp/steps/STEPS_Report_Oman2006.pdf (accessed March 2013).
54. Al-Nozha MM, Al-Mazrou YY, Al-Maatouq MA *et al.* (2005) Obesity in Saudi Arabia. *Saudi Med J* **26**, 824–829.
55. Anon (date not known) Untitled risk factor data from Saudi Arabia; Ministry of Health Saudi Arabia, Kind Saudi University. From WHO Global Database on Body Mass Index. <http://apps.who.int/bmi/> (accessed March 2011).
56. Al-Hamdan NA, Kutbi A, Choudhry AJ *et al.* (2005) *WHO Stepwise approach to NCD Surveillance Country-Specific Report Saudi Arabia (STEPS 2005)*. Saudi Arabia: MoH Kingdom of Saudi Arabia.
57. Erem C, Yildiz R, Kavgaci H *et al.* (2001) Prevalence of diabetes, obesity and hypertension in a Turkish population (Trabzon city). *Diabetes Res Clin Pract* **54**, 203–208.
58. Hatemi H, Yumuk VD, Turan N *et al.* (2003) Prevalence of overweight and obesity in Turkey. *Metab Syndr Relat Disord* **1**, 285–290.
59. Yumuk VD, Hatemi H, Tarakci T *et al.* (2005) High prevalence of obesity and diabetes mellitus in Konya, a central Anatolian city in Turkey. *Diabetes Res Clin Pract* **70**, 151–158.
60. Erem C, Arslan C, Hacıhasanoglu A *et al.* (2004) Prevalence of obesity and associated risk factors in a Turkish population (Trabzon city, Turkey). *Obes Res* **12**, 1117–1127.
61. Oğuz A, Temizhan A, Abaci A *et al.* (2008) Obesity and abdominal obesity; an alarming challenge for cardio-metabolic risk in Turkish adults. *Anatolian J Cardiol* **8**, 401–406.
62. Iseri A & Arslan N (2009) Obesity in adults in Turkey: age and regional effects. *Eur J Public Health* **19**, 91–94.