A Review of Adult Obesity Research in Malaysia

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ABSTRACT
A literature search of articles as detailed in the paper Bibliography of clinical research in Malaysia: methods and brief results, using the MeSH terms Obesity; Obesity, Abdominal; and Overweight; covering the years 2000 till 2015 was undertaken and 265 articles were identified. Serial population studies showed that the prevalence of obesity increased rapidly in Malaysia in the last decade of the twentieth century. This follows the rising availability of food per capita which had begun two to three decades previously. Almost every birth cohort, even up to those in their seventh decade increased in prevalence of overweight and obesity between 1996 and 2006. However, the rise in prevalence in obesity appears to have plateaued after the first decade of the twentieth century. Women are more obese than men and Malays and Indians are more obese than Chinese. The Orang Asli (Aborigines) are the least obese ethnic group in Malaysia but that may change with socio-economic development. Neither living in rural areas nor having low income protects against obesity. On the contrary, a tertiary education and an income over RM4,000/month is associated with less obesity. Malaysians are generally not physically active enough, in the modes of transportation they use and how they use their leisure time.

Other criteria and measures of obesity have been investigated, such as the relevance of abdominal obesity, and the Asian criteria or Body Mass Index (BMI) cut-offs value of 23.0 kg/m² for overweight and 27.0 kg/m² for obesity, with the view that the risk of diabetes and other chronic diseases start to increase at lower values in Asians compared to Europeans. Nevertheless the standard World Health Organization (WHO) guidelines for obesity are still most widely used and hence is the best common reference.

Guidelines for the management of obesity have been published and projects to combat obesity are being run. However, more effort needs to be invested. Studies on intervention programmes showed that weight loss is not easy to achieve nor maintain. Laboratory research worldwide has uncovered several genetic and biochemical markers associated with obesity. Similar studies in Malaysia have found some biomarkers with an association to obesity in the local population but none of great significance.

KEY WORDS:
overweight, obesity, Malaysia, abdominal obesity, physical activity, food intake, hypertension, diabetes, metabolic syndrome, psychiatric conditions, breast cancer, colorectal cancer

INTRODUCTION
265 articles were identified and examined in a literature search on adult obesity in Malaysia. The search using the medical subject headings (MeSH) Obesity; Obesity, Abdominal; and Overweight; followed the method that has been previously described. In brief, clinical research publications containing data on Malaysia for the period Jan 2000 - Dec 2015 were included (last search date 2 Feb 2016). Conference proceedings (but not conference abstracts), relevant theses/dissertation, books/book chapters, reports and clinical practice guidelines were included. 365 articles were initially identified, but 100 articles pertaining to childhood and adolescent obesity were excluded.

Nutrition is vital for health. Undernourishment was a significant burden on human health in the past. However, human morbidity and mortality increases not only with undernourishment but also with excessive nutrition. Obesity, the disease of excessive adipose tissue is increasingly prevalent worldwide.

The WHO criteria for Body Mass Index (BMI) classifies a BMI of 25-29.9 kg/m² as overweight and >30 kg/m² as obese. BMI does overestimate obesity in muscular individuals and underestimate it in such as the elderly who have lost body mass. However, it still is the most widely used index for obesity. Obesity is recognised as a major determinant of non-communicable diseases such as cardiovascular disease, cancers, type 2 diabetes mellitus, respiratory problems, gallbladder diseases, post-operative morbidity and musculoskeletal disorders such as osteoarthrosis.

There has been a clearly documented dramatic increase in the prevalence of obesity in Malaysia over the last three decades since large scale population data became available. The rise of obesity is not a problem unique to Malaysia. In the global context, alongside development and prosperity, in many countries especially in Asia, obesity has become a leading health issue.

This process has been termed nutrition transition, from low availability of calories mainly in the form of plant products to diets high in fats, sugars and energy dense processed foods. This in turn has been the result of rapid economic development which has taken place in Malaysia in the last quarter of the twentieth century. Malaysia has recently been ranked second highest in East and Southeast Asia in terms of being overweight.
SECTION 1: REVIEW OF LITERATURE

PREVALENCE OF OBESITY

In the Adult* Population

There have been five large (>10,000 respondents) national population studies on the prevalence of obesity (Table I).

The National Health Morbidity Survey (NHMS II) in 1996 found that 16.6% of the adult population are overweight and 4.4% obese.1 (This study is often quoted as finding a prevalence 20.7% of individuals aged 20 years and older who were overweight and 5.8% obese).2 Six year later, the Malaysian Adults Nutrition Survey (MANS) carried out between October 2002 and July 2003,3 found that the prevalence of obesity had more than doubled and that the number of adults overweight increased more than 60%. If that rather rapid increase in the prevalence of obesity seemed hard to believe, the findings were confirmed in another study in 2004.4 Following shortly, the Third National Health and Morbidity Survey (NHMS III) in 2006 conducted among 33,055 adults found 29.1% were overweight and 14.0% obese.5 When the next NMHS was done five years later in 2011, it showed only a slight increase in the rates of those overweight and obese, hopefully indicating the rising rate has reached a plateau.6 (Figure 1 and 2)

Age

The NSCVDRF study only reported data for obesity and not overweight. Leaving that study aside the other four large population nutritional surveys come at almost 5-year intervals. The MANS study is two years late in 2003 instead of 2001. The data for these four large studies can be put alongside each other for examination of the prevalence of overweight and obesity in the various age groups.

The prevalence of both overweight and obesity are lowest among young adults but more than doubles to a peak in middle age (Figure 3 and 4). In the NHMS II in 1996, the peak age for obesity was the 40-49 year age band (Figure 4). In the NMHS III,4 reported age in 5-year bands, the peak was the 50-54 year age band and in the NMHS 20116 the peak had moved further to the 55-59 year band (Figure 4). It therefore appears that the cohort born between 1952-1957 carried the high peak of obesity with them as they aged.

Does the rising prevalence of obesity mean only the young age groups move up in age carrying their higher prevalence with them or did all age groups also increase in weight? Figures 5 and 6 which shows the prevalence of overweight and obesity by birth cohorts shows us that every birth cohort increased in prevalence of overweight and obesity between 1996 and 2006. Even the cohort born between 1927-1936 who were >60 years old in 1996 showed an increased in prevalence of overweight and obesity 10 years later in the NMHS III survey when they were the >70 year age group (prevalence of overweight 15.6% rose to 21.1-29.3%, obesity 3.1% rose to 7.2-8.6%). It appears that the period between 1996 and 2006 saw the most rapid rise in weight gain in the Malaysian population.

However, between 2006 and 2011, cohorts born before 1952, i.e. those who were above 55 years old in 2006, appeared no longer to have increased in prevalence of overweight (Figure 5), but instead plateaued or even decreased slightly in prevalence. As regards obesity four cohorts, starting with those born between 1957-1961, i.e. above 50 years old in 2006, showed a decline in prevalence even though two cohorts showed an increase in obesity prevalence.

The Elderly

As noted, from the age of about 60 years upwards, the prevalence of overweight and obesity declines. The prevalence of obesity declines more rapidly than overweight, reaching less than half the peak age value in the 70-75 year age group (Figure 4). The prevalence of overweight on the other hand stays up to 60-70% the peak age prevalence rates (Figure 3). This may indicate the obese suffer a higher mortality rate. The decline in prevalence among those 80-years is even more striking. Their prevalence of obesity is only half that of the 75-79 year age group (Figure 4).

Suzana et al. have also noted that while a large proportion of the elderly may be overweight and obese, signs of malnutrition may be present among them10,11 (malnutrition will not be explored further in this review).

Sex

Consistently across the studies, more women are obese than men,6,7,10,11 but more men are overweight than women.4,5 Only among young adults are more men obese than women.6,7 By the late 20s women have overtaken men in obesity; the cause of this is usually attributed to weight gain after pregnancy. This greater prevalence of overweight among men was especially true among Chinese but among Indians more women are overweight compared to men.6 It appears that when women put on weight they ‘go all the way’. Furthermore, the gap between the prevalence of obesity between women and men has widened.4,6

Three studies reported the prevalence of obesity by age and also by sex.4,6,7 In the NHMS II and NSCVDRF studies7 men appeared to have a peak age younger than women, but that is not clear in the MANS study.6

Suzana et al. have noted that elderly women are twice as obese as men, and by weight circumference (measure for abdominal obesity) women are three times as obese as men.10,11

There have been several studies focusing specifically on women (Table III). Chee et al. found that the prevalence of overweight among women electronic factory worker for younger age groups were similar to the survey NHMS II done four years before, but older women electronic factory worker had higher overweight prevalence and mean BMI than the national sample.14 It has also been noted that being overweight and obese was associated with earlier menarche among women in a study of university students.15

Ethnic Differences

Across the national population surveys, Indians are more overweight than Chinese and Malays.4,5 (Table VI) except perhaps in the NHMS 2011, where Malays appear to have edged ahead. The rise in Malays appears to be at a faster
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Table I: Sample size and prevalence of overweight and obesity of Large Malaysian Obesity Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Overweight (%)</th>
<th>Obesity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Health and Morbidity Survey II (NHMS II) 1996</td>
<td>28,737</td>
<td>16.5%</td>
<td>4.4%</td>
</tr>
<tr>
<td>Malaysian Adults Nutrition Survey (MANS) 2003</td>
<td>10,216</td>
<td>26.7%</td>
<td>12.2%</td>
</tr>
<tr>
<td>The National study on Cardio-Vascular Disease Risk Factors (NSCVDVF) 2004</td>
<td>16,127</td>
<td>11.7%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Third National Health and Morbidity Survey (NHMS III) 2006</td>
<td>33,055</td>
<td>29.1%</td>
<td>14.0%</td>
</tr>
<tr>
<td>National Health and Morbidity Survey 2011 (NHMS 2011)</td>
<td>28,498</td>
<td>29.4%</td>
<td>15.1%</td>
</tr>
</tbody>
</table>

# Prevalence among 20 years and above, ## Prevalence among 15 years and above

Table II: Prevalence of Overweight and Obesity by sex

<table>
<thead>
<tr>
<th>Study</th>
<th>Overweight (%)</th>
<th>Obese (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>NHMS 1996</td>
<td>20.1</td>
<td>21.4</td>
</tr>
<tr>
<td>MANS 2003</td>
<td>28.6</td>
<td>24.8</td>
</tr>
<tr>
<td>NSCVDVF 2004</td>
<td>29.7</td>
<td>28.6</td>
</tr>
<tr>
<td>NHMS 2011</td>
<td>30.9</td>
<td>27.8</td>
</tr>
</tbody>
</table>

Table III: Prevalence of overweight and obesity among women in several localised studies

<table>
<thead>
<tr>
<th>Author, year of study</th>
<th>Sample size</th>
<th>Age group (years)</th>
<th>Characteristics</th>
<th>Ethnicity (%)</th>
<th>Overweight</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chee, 2000</td>
<td>1612</td>
<td>17-55</td>
<td>Women Electronic factory workers</td>
<td>Malays=78.5 Chinese=2.2 Indians=17.7</td>
<td>24.1</td>
<td>13.3</td>
</tr>
<tr>
<td>Sidik, 2004</td>
<td>972</td>
<td>20-59</td>
<td>Women in Selangor</td>
<td>Malays=54.9 Chinese=20.0 Indians=23.4</td>
<td>19.4</td>
<td>6.2</td>
</tr>
<tr>
<td>Poh, 2006</td>
<td>253</td>
<td>30-45</td>
<td>Women Teachers and civil servants in Kuala Lumpur</td>
<td>Malays=64.4 Chinese=26.1 Indians=9.5</td>
<td>53.4</td>
<td>28.8</td>
</tr>
<tr>
<td>Nor'sadah, 2000</td>
<td>175</td>
<td>20-70</td>
<td>Women with Breast Cancer, Kelantan</td>
<td>Malays=77.7 Chinese=20.6 Others=1.7</td>
<td>34.3</td>
<td>13.7</td>
</tr>
<tr>
<td>Yong, 2007</td>
<td>368</td>
<td>20-75</td>
<td>Women with Breast Cancer, from 8 different Hospitals</td>
<td>Malays=77.7 Chinese=33.2 Indians=9.5</td>
<td>31.5</td>
<td>10.9</td>
</tr>
<tr>
<td>Lee, 2011</td>
<td>115</td>
<td>20-59</td>
<td>Women Office Workers, Kuala Lumpur and Selangor</td>
<td>Malays</td>
<td>33.0</td>
<td>22.6</td>
</tr>
<tr>
<td>Siti Affira, 2011</td>
<td>215</td>
<td>18-55</td>
<td>Women in Corporate Companies, Petaling Jaya</td>
<td>Malays=81.9 Chinese=10.2 Indians=7.9</td>
<td>24.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Lua, 2011</td>
<td>41</td>
<td>24-68</td>
<td>Women with Breast Cancer, Terengganu and Kelantan</td>
<td>Malays=92.7 Chinese=7.3</td>
<td>29.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Hasnah, 2011</td>
<td>125</td>
<td>50-65</td>
<td>Women in Low cost Housing Cheras</td>
<td>Malays</td>
<td>45.6</td>
<td>31.2</td>
</tr>
</tbody>
</table>

Table VI: Prevalence of Overweight and Obesity by ethnic group

<table>
<thead>
<tr>
<th>Study</th>
<th>Ethnicity</th>
<th>Overweight (%)</th>
<th>Obese (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Malays</td>
<td>Chinese</td>
<td>Indians</td>
</tr>
<tr>
<td>NHMS II</td>
<td>16.5</td>
<td>15.1</td>
<td>18.6</td>
</tr>
<tr>
<td>MANS 2003</td>
<td>27.2</td>
<td>25.0</td>
<td>31.0</td>
</tr>
<tr>
<td>NSCVDVF 2004</td>
<td>29.8</td>
<td>28.5</td>
<td>33.2</td>
</tr>
<tr>
<td>NHMS 2011</td>
<td>31.1</td>
<td>27.6</td>
<td>30.8</td>
</tr>
</tbody>
</table>

Table V: Prevalence of Overweight and Obesity by sex and ethnic groups

<table>
<thead>
<tr>
<th>Study</th>
<th>Ethnicity</th>
<th>Overweight (%)</th>
<th>Obese (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>NHMS 1996</td>
<td>20.0</td>
<td>29.3</td>
<td>4.3</td>
</tr>
<tr>
<td>MANS 2003</td>
<td>24.5</td>
<td>25.2</td>
<td>3.8</td>
</tr>
<tr>
<td>NSCVDVF 2004</td>
<td>24.2</td>
<td>29.3</td>
<td>3.8</td>
</tr>
</tbody>
</table>
rate. Indians of both sexes are more overweight than Chinese and Malays (Table V), the difference between Indian women and the other ethnic groups being wider than among the men.4,6

Data comparing men and women separately by ethnic groups are only available in three studies.4,6,7 Malay and Indian women are equally obese but Chinese women have only about half their prevalence rates. Chinese women are about equally as obese as Chinese men, but both Malay and Indian women are much more obese than their male counterparts. Among men, Chinese had the highest prevalence of obesity in 1996, but they have been overtaken by both Indian and Malay men in later studies.6,7

Two studies listed the bumiputra of Sarawak and Sabah as separate categories,6,7 which allows better observations to be made than when they are put together as just other indigenous people or others.4,8,9 The results shown in Table VI are inconsistent, probably due to sampling error as there are many bumiputra groups spread over a wide area in both states. Their prevalence of overweight and obesity in 2003-2004 are lower than those of Indians and Malays and comparable to the rates among Chinese. It is hard to say with certainty whether the men or women are more overweight and obese. Except for one study which found bumiputra men in Sabah more overweight and obese than women (MANS), the rest of the data shows bumiputra women in Sarawak more overweight and obese than men, as did the NSCVDRF study find in contradiction with the MANS data (Table VI).

The ethnic group with the lowest prevalence of obesity in Malaysia are the Orang Asli. None of the Orang Asli were obese in the MANS study, and only 15% were overweight, but they only had a sample size of 28 Orang Asli. We must look at more focused studies for information. Chronic Energy Deficiency (CED) or under-nutrition (BMI <18.5 kg/m²) has been and is still the larger nutritional problem among Orang Asli, but that is not the subject of this review.

A nutritional status survey of Orang Asli adults (Jahai, 58.7%, Temiar, 41.3%) in Lembah Belum, Grik, of 138 subjects found 26.7% underweight and 10.1% were either overweight/obese.24 Based on percentage body fat and waist circumference (WHO criteria) only one (0.7%) was obese. A study of 57 adult Orang Asli (Che Wong) in Pahang found three men (10.3%) and 8 women (29%) overweight and one man (3.3%) obese.25 However, where the Orang Asli live very close to economic development such as in Sungai Bull in Cameron Highlands, among 138 respondents, by BMI 25.4% were overweight and 34.8% obese.26 In wide survey (n=636) of Orang Asli, classifying them by tribes (Proto-Malays, Senois and Negritos), as well as by socio-economic groups (Urbanized City Fringe Dwellers (UCFD), Resettled Communities (UC) and Deep Forest Hunter Gatherers (DFHG)), Phipps et al. found the prevalence of obesity ranged from 7.5-10.0% among the Proto-Malays, 4.5-10.0% among Senoi and only 2.6-5.5% among Negritos. By socio-economic groups, 31.6% of UCFD, 12.0% of RC and 2.0% of DFHG were obese.27

Table VI: Prevalence of Overweight and Obesity by sex among bumiputra in Sabah and Sarawak

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>Overweight</th>
<th></th>
<th></th>
<th></th>
<th>Obese</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bumiputra</td>
<td>Bumiputra</td>
<td>Bumiputra</td>
<td>Bumiputra</td>
<td>Bumiputra</td>
<td>Bumiputra</td>
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<tr>
<td></td>
<td>Sabah</td>
<td>Sarawak</td>
<td>Sabah</td>
<td>Sarawak</td>
<td>Sabah</td>
<td>Sarawak</td>
<td>Sabah</td>
</tr>
<tr>
<td>Men</td>
<td>MANS 2003</td>
<td>NSCVDRF 2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sabah</td>
<td>24.3</td>
<td>24.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarawak</td>
<td>23.2</td>
<td>31.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>6.1</td>
<td>9.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sabah</td>
<td>7.4</td>
<td>8.5</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sarawak</td>
<td>8.4</td>
<td>12.3</td>
<td></td>
<td></td>
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<td></td>
</tr>
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</table>

Table VII: The prevalence of overweight and obesity by state in Malaysia

<table>
<thead>
<tr>
<th>State</th>
<th>Overweight (%)</th>
<th>Obesity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NHMS II</td>
<td>NHMS III</td>
</tr>
<tr>
<td>Johore</td>
<td>17.4</td>
<td>28.9</td>
</tr>
<tr>
<td>Kedah</td>
<td>14.9</td>
<td>31.1</td>
</tr>
<tr>
<td>Kelantan</td>
<td>12.9</td>
<td>28.3</td>
</tr>
<tr>
<td>Melaka</td>
<td>18.9</td>
<td>31.1</td>
</tr>
<tr>
<td>N Sembilan</td>
<td>19.4</td>
<td>29.5</td>
</tr>
<tr>
<td>Pahang</td>
<td>18.3</td>
<td>28.8</td>
</tr>
<tr>
<td>Penang</td>
<td>15.9</td>
<td>29.3</td>
</tr>
<tr>
<td>Perak</td>
<td>18.0</td>
<td>27.6</td>
</tr>
<tr>
<td>Perlis</td>
<td>18.2</td>
<td>32.1</td>
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<tr>
<td>Sabah</td>
<td>14.5</td>
<td>24.9</td>
</tr>
<tr>
<td>Sarawak</td>
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<td>28.7</td>
</tr>
<tr>
<td>Selangor</td>
<td>17.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Terengganu</td>
<td>17.9</td>
<td>28.6</td>
</tr>
<tr>
<td>Wilayah Per</td>
<td>17.5</td>
<td>29.8</td>
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</table>
Table VIII: Prevalence of Overweight and Obesity in several small localised studies

<table>
<thead>
<tr>
<th>Author, year of study</th>
<th>Sample size</th>
<th>Age group (years)</th>
<th>Characteristics</th>
<th>Ethnicity (%)</th>
<th>Overweight</th>
<th>Obesity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohd Yunus, 1999</td>
<td>570</td>
<td>&gt;15</td>
<td>Households in Dengkil, Selangor</td>
<td>Malays=23.3 Chinese=57.1 Indians=30.5 Orang Asli=30.8</td>
<td>12.0 14.3 10.5 11.5</td>
<td></td>
</tr>
<tr>
<td>Nawawi, 2004</td>
<td>609</td>
<td>30-65</td>
<td>Rural Community Raub, Pahang</td>
<td>Malays</td>
<td>33.5</td>
<td>11.2</td>
</tr>
<tr>
<td>Rampal, 2004</td>
<td>2219</td>
<td>&gt;15</td>
<td>Households in Selangor</td>
<td>Malays=52.9 Chinese=30.9 Indians=15.4</td>
<td>15.2 7.3 11.6</td>
<td></td>
</tr>
<tr>
<td>Nazri, 2005</td>
<td>348</td>
<td>&gt;18</td>
<td>Households in PulauKundur, Kelantan</td>
<td>Malays=99.4</td>
<td>49.1</td>
<td></td>
</tr>
<tr>
<td>Chang, 2007</td>
<td>260</td>
<td>20-65</td>
<td>Rural Community, Serian, Sarawak</td>
<td>Malays=32.3 Bidayuh=33.1 Iban=34.6</td>
<td>14.3 11.6 10.0</td>
<td></td>
</tr>
<tr>
<td>Mohamud, 2007</td>
<td>4428</td>
<td>&gt;18</td>
<td>Households in 5 Different states</td>
<td>Malays=62.5 Chinese=14.6 Indians=8.5</td>
<td>34.0 37.5 24.6 12.3</td>
<td></td>
</tr>
<tr>
<td>Akter, 2007</td>
<td>219</td>
<td>&gt;18</td>
<td>Bukit Sekelau (rural) Pahang</td>
<td>Malays</td>
<td>54.8(BMI&gt;27.5)</td>
<td></td>
</tr>
<tr>
<td>Narayan, 2010</td>
<td>441</td>
<td>&gt;20</td>
<td>Coastal Villages, Kedah</td>
<td>Malays</td>
<td>25.9 17.0</td>
<td></td>
</tr>
<tr>
<td>Shahar, 2009</td>
<td>820</td>
<td>&gt;60</td>
<td>4 Rural Villages</td>
<td>Malays</td>
<td>24.7 11.4</td>
<td></td>
</tr>
<tr>
<td>Jan Mohamed, 2009</td>
<td>237</td>
<td>18-59</td>
<td>Bachok, Kelantan</td>
<td>Malays</td>
<td>41.7 13.4</td>
<td></td>
</tr>
<tr>
<td>Rampal, 2010</td>
<td>454</td>
<td>30-68</td>
<td>University staff in Selangor</td>
<td>Malays=86.3 Chinese=8.8 Indians=4.9</td>
<td>30.1 37.5 17.5 0</td>
<td></td>
</tr>
<tr>
<td>Chew, 2011</td>
<td>258</td>
<td>&gt;21</td>
<td>Suburban New Village Selangor</td>
<td>Malay</td>
<td>29.6 20.6</td>
<td></td>
</tr>
<tr>
<td>Hazizi, 2014</td>
<td>233</td>
<td>18-59</td>
<td>Government Employees Penang</td>
<td>Malays</td>
<td>24.3 58.5</td>
<td></td>
</tr>
<tr>
<td>Ayiesah, 2014</td>
<td>82</td>
<td>21-59</td>
<td>Military Hospital Staff Malacca</td>
<td>Malays</td>
<td>24.3 58.5</td>
<td></td>
</tr>
<tr>
<td>Nor Afiah, 2014</td>
<td>211</td>
<td>19-24</td>
<td>Medical Students</td>
<td>Malays=63.5</td>
<td>16.6 3.8</td>
<td></td>
</tr>
<tr>
<td>Kabir, 2012-14</td>
<td>945</td>
<td>20-43</td>
<td>Postgraduate University Students,</td>
<td>Malays=79.3 Chinese=13.5 Indians=5.0 Others=2.2</td>
<td>23.1 8.9</td>
<td></td>
</tr>
</tbody>
</table>

Table IX: Physical Activity among Malaysians

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
<th>Physically Inactive</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHMS II</td>
<td>16.2%</td>
<td>7.7%</td>
<td>60%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>MANS</td>
<td>18.9%</td>
<td>9.4%</td>
<td>60.0%</td>
<td>77.7%</td>
<td></td>
</tr>
<tr>
<td>MyNCD5-1</td>
<td></td>
<td></td>
<td>55.4%</td>
<td>60.1%</td>
<td></td>
</tr>
<tr>
<td>NMHS III</td>
<td></td>
<td></td>
<td>35.3%</td>
<td>50.5%</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1: Percentage of Malaysians overweight and obese (BMI>25kg/m²) in studies from 1996 to 2015.

Fig. 2: Percentage of Malaysians obese (BMI>30kg/m²) in studies from 1996 to 2015.
Fig. 3: Prevalence of Overweight (BMI 25-29 kg/m²) among Malaysians of Different Age Groups.

Fig. 4: Prevalence of Obesity (BMI >30 kg/m²) among Malaysians of Different Age Groups.

Fig. 5: Prevalence of Overweight at Various Age Groups for Different Birth Cohorts using data from NMHS II, MANS, NHMS III, NHMS 2011 and NMHS 2015.

Fig. 6: Prevalence of Obesity (BMI >30 kg/m²) at Various Age Groups for Different Birth Cohorts using data from NMHS II, MANS, NHMS III and NHMS 2011.

Fig. 7: Change in available calories, fat and protein per capita in Malaysia 1961-2011.

Source: FAO food balance sheet

Fig. 8: Changes in source of calories in Malaysia between 1970 and 2009.

and 32.1% (Perlis) and rates of 11.5% (Sarawak) and 18.6% (Negeri Sembilan) for obesity. Sabah (10.6%) continued to show the lowest rate for obesity in the NMHS 2011, but Melaka had the lower prevalence of overweight (25.7%). The trend indicates that over these critical years nutritional availability, the main driver for obesity levelled out geographically throughout Malaysia.

The MANS study also looked at geographical variation and grouped the states in Peninsular Malaysia into four groups, Northern, Central, South and East, besides Sabah and Sarawak. This study considered the difference by sex which the NHMS II did not. There was no significant difference in the overweight category. Neither was there a significant difference in obesity among men. But women in Sabah (8.4%) and Sarawak (9.33%) were much less obese than in Peninsular Malaysia (12.5-13.8%). Women in the Southern Peninsular states had the highest prevalence of obesity (13.8%).

Most studies in the twenty-first century have found no difference in the prevalence of overweight and obesity between rural and urban areas. Although large national studies provide a picture of the average and overall prevalence of obesity, the Malaysian population is not homogenous. Age, sex, locality and social characteristics produce variations in the prevalence of obesity. Several small localised studies have mapped out finding is certain pockets of the population. Table VIII shows the prevalence of obesity found in several of these studies.

Social and Economic Factors

Education

The consistent pattern in the large nutritional status population studies is that the better educated are less obese. Those with tertiary education have the lowest prevalence rates. On the other hand, those having no education is also associated to overweight and obesity rates slightly lower than those with primary and secondary education.

Occupation

The studies have not exhaustively nor consistently listed all occupations. However, one category that are often most obese are the Administrative, or Senior Officer/Manager or as listed in the NMHS 2011; Government/Semi government employee. Although these terms are not equivalent, these categories have been the most obese or overweight in their respective studies. On the other hand, professionals are not usually most obese. The other occupation group that is also either most overweight or obese are housewives. Mohd Nazri et al. and Lim et al. report that shift work was associated with higher BMI among male and female factory workers. Moy et al. reported similar findings among mainly female medical care shift workers.

Income

The prevalence of obesity in Malaysia shows that food availability is to a large extent is no longer dependant on having enough income. There is a trend that the prevalence of overweight and obesity rises slowly from the poorest groups to the personal or household income level of RM4,000 a month. After that, the prevalence drops slightly at first, in the RM4,000-RM5,000 bracket and noticeably in the >RM5,000 bracket. In the NMHS II data the lowest income group (<RM400) did appear to have noticeably lower prevalence of overweight (24.9%) and obesity (11.5%) compared to a few brackets above (e.g. RM1,000-RM1,999 = 30% overweight, 15.4% obesity) but in the NMHS 2011, that poorest bracket (<RM400) have higher rates than the brackets above it. Tan et al. however have contrary conclusions analysing data from the Malaysia Non-Communicable Disease Surveillance-1 (MyNCDs-1). In a study of low income rural households in Selangor, Zailah and Khor found that more women from food insecure households (56.0%, 65/116) were overweight and obese compared to their food secure counterparts (40.5%, 34/84). Food secure women spent more time in economic activities while food insecure women spent more time in domestic and leisure activities. The hypothesis that food insecurity may lead to binge eating, needs further investigation. Ihab et al. have also reported on the phenomenon of maternal obesity in the presence of childhood malnutrition in low income households. They found 52.0% (116/223) Malay women welfare recipients in Bachok, Kelantan were overweight/obese, while 61.0% (136/223) of the children were overweight. There were 66 pairs (29.6%) of overweight/obese mothers with underweight children. More than half (57%) were single female-headed households, 69% of mothers were employed. Divorced or widowed poor women were five times more likely to be associated with the dual malnutrition condition than poor married women. Large households and a shift to higher consumption of refined grains, meat and edible oils inadequate in micronutrients (nutrition transition) may also be factors underlying this situation.

Dunn et al. have analysed the relationship between socioeconomic characteristics and BMI between Malays and Chinese by quintile regression and concluded that reduction of economic inequality is unlikely to eliminate obesity disparities between Malays and Chinese. Increased effort to alter lifestyle behaviour, they believe, are required.

Abdominal Obesity (AO) and other measures of obesity

There has been debate as a result of some evidence that although BMI is easily measured, it is not a good predictor of cardiovascular and obesity related health risks. Waist circumference (WC), a proxy measure of body fat is said to be a better predictor. BMI is even a poorer predictor of body fat in Asian ethnic groups when calculations derived from a Caucasian population is used. There is concern that among Asians the risk of diabetes and other chronic diseases starts to increase even when BMI or waist circumstance are well within the accepted range for Europeans and it has been suggested that in Asians, the BMI cut-offs should be 23.0 kg/m² for overweight and 27.0 kg/m² for obese, lower than the WHO criteria. Dunn et al. have also reported on

Investigating Cut-off Values

Asians are thought to be more prone to central or visceral obesity (AO). Studies have therefore been done to find more suitable parameters for obesity and its relationship to cardiovascular disease, dyslipidaemia, hypertension and diabetes among Asians and it has been replicated in Malaysia. Using Receiver Operating Characteristic (ROC)
analysis to compare the predictive validity and optimal cut-off values, and the Area under the curve (AUC) to determine its diagnostic power, Zaki Morad et al. found the optimal cut-off value for WC varied from 83.92 cm in men and from 83.88 cm in women in Malaysia, in a sample size of 1,893 individuals from 93 primary care clinics. They also found the optimal BMI cut-off values predicting dyslipidemia, hypertension, diabetes mellitus or at least one CVD risk factor varied from 23.5-25.5 kg/m² in men and 24.9-27.4 kg/m² in women. They concluded that WC may be a better indicator for predicting obesity related CVD risk. BMI is also a weak predictor for diabetes and WC appeared to be better. They also found that at a cut-off for WC >90 cm for men and >80 cm for women, AO was present in approximately 71% patients with lipid disorder, in 76% with hypertension and in 75% with diabetes. Aye and Malek also noted WC was a better predictor than BMI of metabolic risk factors for developing going by the IDF definition of Metabolic Syndrome. The optimal cut-off point of WC they found to predict individual metabolic risk was 84.5-91.0 cm in females and 86.5-91.0 cm for males.

In Caucasian populations the recommended cut-off points for waist circumference are, Waist Action Level 1 (overweight): ≥94 cm for men and ≥88 cm for women; and Waist Action Level 2 (obese) ≥102 cm for men and ≥88 cm for women. Using data from 32,773 subjects who participated in the NHMS III, Kee et al. found that the ROC analyses showed that the appropriate screening cut-off points for WC to identify overweight subjects with BMI ≥25 kg/m² was 86.0 cm for men (sensitivity=83.6%, specificity=82.5%), and 79.1 cm for women (sensitivity=85.0%, specificity=79.5%). The cut-off points to identify obese subjects with BMI ≥30 kg/m² was 93.2 cm for men (sensitivity=86.5%, specificity=85.7%) and 85.2 cm for women (sensitivity=77.9%, specificity=78.0%).

Prevalence of AO
Using standard WC cut-offs of >102 cm in men, >88 cm in women (WHO 1998) Kee et al. found the overall national prevalence of AO among Malaysian adults in the NHMS III was 17.4%. The prevalence was much higher in women (26.0%) than in men (7.2%) (OR: 4.2). The prevalence of AO increased steadily with age until the age of 50 to 59 years, after which the prevalence declined. The prevalence was higher among the Indians (OR: 3.0) and Malays (OR: 1.8) compared to others. With regard to marital status, respondents who were ever married had the higher risk of AO compared to not married (OR: 1.4). As with obesity measured by BMI, an inverse relationship was observed between the level of education and prevalence of AO. Respondents who received no formal education had the highest prevalence at 23.7%, followed by those with primary education (21.2%), secondary education (15.2%) and tertiary education (12.1%). By occupational status, housewives had the highest prevalence of AO compared to other occupations (OR: 1.4, 95% CI: 1.1, 1.7). Among the household income categories, prevalence of AO was lowest in households with greater than RM5000 (13.7%) Income groups between RM1000-3000 had the highest rates (18.2-18.4%).

The prevalence of abdominal obesity among the elderly (≥60years) in the NHMS III in 2006 was 21.4%, 33.4% for women and 7.4% for men. A normal BMI may hide individuals with health risks due to excess fat present as AO. Norafidah et al. noted that being female and non-Malay were factors that were found to be associated with abdominal obesity in the normal BMI population.

Body Fat Percentage
In a study excluding underweight individuals, Goonasegaran et al. put forward the case that body fat percentage (BFP) measuring waist, neck and hip circumference and using the US Navy formula, was a superior measure of obesity to BMI better at differentiating between lean mass and adipose tissue in those mildly obese or overweight.

Morbid Obesity
Obesity is recognised as a risk factor, increasing an individual’s chance of having several major diseases. However, marked obesity of a BMI ≥40 kg/m² is commonly termed morbid obesity, and a disease in its own right. In 1996, 0.3% of the population were found to have a BMI of greater than 40.0 kg/m². Women (0.4%) had a high rate than men (0.2%). Malay women (0.6%) had the highest prevalence of super obesity. Data from the NHMS III showed the overall prevalence of morbid obesity had increased to 1.0%. The peak age of morbid obesity was 45-49 years (1.3%). Indians (1.6%) were the ethnic groups with the highest rate, and housewives (1.5%) the occupation group most morbidly obese. By 2011 the overall prevalence of morbid obesity had risen to 1.3%. Females (1.7%) continued to outnumber males (1.0%). Indians (2.7%) continued to be most affected, followed by Malays (1.9%) but Chinese (0.3%) appeared to be significantly less affected.

RISK FACTORS
Obesity develops when energy intake exceeds expenditure. While recognising that genetic factors and human metabolism can modify the development of obesity, it is obvious that the two greatest driving forces for the rising prevalence of obesity in Malaysia today are the increase of food availability and resulting food consumption linked with inadequate physical activity.

The end of the twentieth century saw economic development in Malaysia that made food easily available. The per capita gross national product of Malaysia grew an average of 8% per annum between 1980 and 2000.66 Urbanisation rose from 25% in 1969 to 41% in 1990 and is expected to reach 60% by 2020.67 Poverty rates fell. The opportunity to become overweight opened up for many.

Food Intake
The quantity and type of food available in Malaysia over the last several decades allow us to understand the rise in prevalence of obesity in the population. Total availability of calories per capita per day in Malaysia was estimated at 2430 kcal in 1961 and increased to 2923-2990 kcal in 2007, a 20% increase over 40 years.68,69 Although food availability actually fluctuates from year to year, Davey et al. point out that in no year after 1992 was there less than 2780 kcal available per capita per day. The FOA food balance sheet shows that available food calories has not continued to rise the last 10 years (Figure 7). Rising prosperity meant the proportion of...
household income spent on food and non-alcoholic beverages declined from 23.8% in 1992-4 to 20.3% in 2009-10 periods, even though in absolute terms the amount spent was RM1161 in 1992-4 compared to RM2190 in 2009-10 periods.85

Calories available from animal products per capita per day rose from 267 kcal in 1967 to 485 kcal in 2007, a rise of 82%, but Figure 7 shows that according to FAO food balance sheet the amount of fats and protein available per capita has also remained stable. The amount of available sugar and sweeteners per capita per year rose from 28.8 kg to 48.7 kg between 1967 and 2007, a rise of 70%. On the other hand, the proportion of calories obtained from cereals decreased from 61% to 41% (Figure 8). For a long time while the price of sugar rose in the world market, its price to the consumer in Malaysia was kept low by a hefty subsidy from the government which was only removed in the year 2014.69

Given there exists some inequality of distribution, the abundance of food explains why almost any segment of the population can become obese.

Data about what the actual energy intake of individuals are is less clear. The mean calorie intake in poor villages, in the 1980s and 1990s, was noted to be 1870 kcal per person per day.86 A 3-day food record survey of 409 adults with normal BMI across Malaysia in 1992-3 recorded a mean energy intake of 2163 kcal/day among the men and 1718 kcal/day among women respectively.72 Overall, 14% of the total energy intake was derived from protein, 23% from fat and 63% from carbohydrate, but urbanites consumed a higher proportion of energy in fats (29%) compared to rural subjects (20%). The energy intake of Indians, surprisingly, was significantly lower than that of other ethnic groups. Malay women recorded a significantly higher energy intake than other ethnic groups. Urban male subjects consumed significantly more energy (2275 kcal) than their rural counterparts (2024 kcal), but this was not the case in women. In both men and women, fat intake was significantly higher in Chinese and urban subjects.77 Among three similar studies of urban post-menopausal Malay and Chinese women, the investigators reported similar energy distribution of their subjects’ dietary intake, which consisted of 53-55% carbohydrate, 15-17% protein and 29-30% fat. Malay women reported a higher daily calorie intake (mean values 1649-1747 kcal) compared to Chinese women (mean values 1550-1591 kcal).72,73,76

Among Malay women Employee Provident Fund (EPF) office workers in Kuala Lumpur and Selangor, Lee et al. found that the mean energy intake for normal weight, overweight and obese subjects was 1685±199 kcal/day, 1810±166 kcal/day and 2119±222 kcal/day, respectively.79 Evidence that the economic transformation of Malaysia from a rural agrarian economy to an urban commercial society has impacted dietary habits can be seen in a dietary survey of selected women electronic factory workers by Lim et al. in 2000. Even though it was only a selected/invited sample of 122 women, of whom one third each was normal/underweight, overweight and obese, it revealed that such women tended to eat meals at irregular hours (61.5%) and nearly half thought healthy foods did not taste nice (47.5%) or were expensive (45.1%). They had a high frequency of taking foods high in fat content and of a diet lacking in variety. Living in a hostel, surprisingly, was a factor associated with less risk of obesity, but the similarity of frequency of pattern of food consumption led the investigators to believe they shared the risk of being obese in the future. Exercise, even when reported, did not reach an intensity to be of benefit. Only 39.3% reported ever trying to lose weight. However, their preference was for slimming products rather than a healthier lifestyle or dietary changes.88

Suriani et al. surveyed overweight and obese working women regards barriers they faced controlling food intake. As regards not eating healthily more frequently the commonest reasons were ‘lack of knowledge’ (79.3%), followed by ‘lack of motivation’ (72.1%) and ‘family commitment’ (71.4%). As regards controlling the quantity of food the commonest responses were ‘attend meetings often’ (60.0%), followed by ‘difficult when eating out’ (57.9%).76

Secondary analysis of the NHMS III food label study of 4,565 obese respondents found they claimed to read and understand the food label. 74.5% read the expiry date but less than 20% read information about food component content.89

The consumption of soft drinks was reported to be a significant risk factor that is associated with being overweight among medical student.77 Choong et al. found no correlation between preference for and frequency of consumption of salty food and being overweight among 300 university students.78 Swarna Nantha argues that the increasing rate of sugar consumption in Malaysia should be viewed as sugar addiction and addictive behaviour considered in relation to health policy development regarding obesity.79

Physical Activity

The NMHS surveys, and other large surveys like the MANS, and MyNCDs-1 have reported physical activity data of Malaysian adults, and have wide ranging values (Table IX). It would go beyond the scope of this review to report these findings in depth and review all studies on physical activity.

Poh et al. have examined the physical activity status of 7,349 respondents of the MANS study of 2003, which covered all states and ethnic groups in Malaysia.44

Transport: In that study, 74.4% used passive modes of transport such as cars and motorcycles as their main mode of transport. 9.2% used public transport, (which involves slightly more physical activity) and 17.7% walked or cycled. Not surprisingly the rural population walked more (23% vs. 14% urban). The bumiputra of Sabah, Sarawak and Orang Asli walked much more (45-50%) than the Malays, Chinese and Indians (11-15%). More women (24.3%) walked than men (13.8%).44

Exercise: Poh et al. found that 31.3% of the population had engaged in some form of exercise in the two weeks prior to the interview (ever-exercised) (40.0% of men, 22.3% of women). 14.2% of the respondents reported adequate exercise, defined as at least 20 minute sessions at least three times a week. In both these measures of exercise the rate was higher in urban compared to rural adults. The East Coast states had an unusually low rates of exercise among the
different regions. Young adults (18-19 years) reported the highest rates of exercise. The overweight group reported most exercise, even exceeding the normal and underweight. The obese exercised least.40

Physical Activity Pattern: Physical activity level (PAL) was calculated as the ratio of total energy expenditure (TEE) to basal metabolic rate (BMR). Across the population the PAL was 1.6-1.7 and did not differ much between urban or rural areas, between men and women, between ethnic groups, or between normal or overweight group.41 The desirable PAL score to avoid obesity is one above 1.75. A low score reflecting a very sedentary lifestyle is 1.4.

The WHO study on non-communicable disease risk factors and socioeconomic inequalities found that men in rural areas were more likely to be engaged in occupations with a high level of physical activity (33.7%) compared to urban dwellers (23.5%), similarly for women (19.7% rural vs 15.9% urban). The lower income men (<RM1000) also had a higher level of occupational physical activity (31.2%) compared to high income earners (>RM3999) (22.2%) and the same was true for women (16.4% high income vs. 12.1% low income). On the other hand, higher education and higher income was associated with more leisure time physical activity for both men and women. Indian men had an unusually low rate of leisure time physical activity.42

Kabir et al. surveyed 945 post-graduate students in University Putra Malaysia (UPM), with a mean age of 27 years and found 32% had a BMI >25 kg/m2. 44% had low physical activity and they were twice as likely to be overweight or obese.43

A study of 136 security guards and their wives in Kuala Lumpur found that only 39.2% ever-exercised and 13.8% exercised adequately.44 Hazizi et al. determined that among 210 Malay employees in the Federal Government Building in Penang that 64.8% had low physical activity, measured by an accelerometer clipped to the subjects belt/skirt/trousers at the waist.45

Among women working in corporate companies in Petaling Jaya, aged between 18-55 years, 48.8% were found to be moderately active and 28.8% were highly active according to the International Physical Activity Questionnaire-short form (IPAQ, 2005) in a study by Siti Affira et al. These rates were higher than in larger population surveys and they found monthly income correlated positively with physical activity. There was however no significant association between job category and physical activity.46 Lim et al. found that 29.5% of women working in electronic factories in Selangor had adequate exercise.47

Wan Nudri et al. found that men who reported having no exercise were significantly more overweight than men who regularly exercised and sportsmen who actively participated in competition, in a cross-sectional study of randomly selected men from government departments in Kota Bharu.48 Low physical activity also correlated to obesity in studies among staff in a military hospital and individuals attending health clinics in Sepang, by Ayiesah et al.49 and Hejar et al.50 respectively, and also in government employees in Penang.48

Among the obese pre-diabetics in Negeri Sembilan, Ibrahim et al. found 60.8% were physically inactive using the IPAQ, 2005.51

ASSOCIATION OF OBESITY WITH OTHER DISEASES

Metabolic Syndrome

Central obesity, raised blood lipids, hypertension and a raised fasting blood sugar have been collective recognised as manifestation of an insulin resistant state. The prevalence of metabolic syndrome has been addressed in a separate article.46 This section will only highlight the various elements of metabolic syndrome as they are related to obesity. In any population of obese individuals, each of these other factors can be expected to be high.

For example, Mofauzy reported in a study of 1,099 diabetic clinic patients across 19 public hospitals (Ministry of Health and University Hospitals) in Peninsular Malaysia that 66.9% of males and 82.1% of females had a waist circumference (Asian WC) >90 cm (males) and >80 cm (females).52 Abougalambou et al. found that 81.5% of their patients at the diabetic outpatient clinics from Hospital Universiti Sains Malaysia were obese.53 66.8% of diabetics were found overweight and 15.8% obese in a study of 196 type 2 diabetic patients the University Malaya Medical Centre primary health clinic.54 Eid et al. noted that a BMI value above target level was observed in 66% (140/211) of their diabetic patients.55 Foo et al. found that 75% (121/161) of their diabetic subjects were centrally obese using the Asian WC criteria.56 They showed a predominance of insulin resistance over secondary dysfunction using the Homeostatic Model Assessment (HOMA) proposed by Matthews et al.57 Lim et al. have confirmed a bimodal peak of blood glucose distribution with BMI in all ethnic groups in Malaysia.58

Among 268 semi-urban pre-diabetics (individuals with blood glucose concentrations higher than normal but not high enough to be classified as diabetic) attending two primary care clinics, Ibrahim et al. found 21.6% were overweight and 71.3% obese. Using a health-related quality of life (HRQOL) survey they found those overweight and obese had a lower HRQOL score compared to the small number (7.1%) of normal weight individuals.59

Hypertension has been noted to be more prevalence among the obese in numerous studies in Malaysia as well.60,61 even in rural Kedah62 and Sarawak.63 The same higher prevalence of raised blood cholesterol among the overweight and obese.64,65

Cardiovascular Diseases

Su et al. found that although obesity as measured by BMI did not correlate to cardiovascular risks (r=0.038 p=0.26), as measured by the Framingham Risk Score (FRS), among urban Malaysians (n=882), other measures of obesity: namely waist-to-hip ratio (WHR) (r=0.44, p<0.001) waist circumference (WC) (r=0.28, p<0.001) and Waist to Height Ratio (WHtR) (r=0.23, p<0.001) were correlated to cardiovascular risks.66 Moy et al. noted a weak but significant correlation between the FRS for coronary heart disease and three measure of obesity (BMI, WC and Weight-Height-Ratio) among Malay men working as security guards.67
In a cross-sectional study of 36 lean and 36 obese subjects, Al-Tahami et al. found that endothelial dependent vasodilatation was lower in obese compared to lean subjects (40.53±6.59 vs. 71.03±7.13 AU).\(^{100}\) They also found lower adiponectin levels (8.80±0.43 vs. 25.93±0.40 µg/ml) in obese compared to lean subjects. Sanip et al. found serum adiponectin levels positively correlated with the HOMA insulin sensitivity index but no correlation with microvascular endothelial function indices in a sample of 91 overweight and obese females with no other metabolic syndrome markers.\(^{101}\) Nafikudin et al. found that the intima-media thickness of common carotid arteries measured by ultrasound were thicker among subjects with some obesity indices, especially those with familial hypercholesterolemia.\(^{102}\)

Surgeons at Hospital Universiti Sains Malaysia, Kubang Kerian reported that there was no significant difference in the surgical outcome of isolated coronary artery bypass graft between overweight and normal weight individuals in a study of 141 of their patients between 2001 and 2004.\(^{103}\)

**Psychiatric Disorders**

Norelelawati et al. found that among their schizophrenic patients attending follow-up at clinic 32% (69/216) were overweight and 28% (60/216) were obese. Again women were more obese than men. No particular type of antipsychotic agent was associated with a higher prevalence of obesity.\(^{104}\) Ainsah et al. found 74.2% (72/97) of their patients on antipsychotics were overweight or obese (by Asian classification of overweight >23kg/m\(^2\)), 71.4% (45/63) of those on atypical antipsychotics and 79.4% (27/34) of those on conventional antipsychotics. The mean WC of those on conventional antipsychotics (93.4cm) was significantly higher than for those on atypical antipsychotics (88.2cm). Those receiving a combination of depot antipsychotics also had a significantly higher WC than those who did not. However, being on concomitant antidepressants was not associated with any significant difference.\(^{105}\) Binge eating disorder was not significantly higher among overweight and obese patients with schizophrenia compared to normal weight schizophrenics, in a study of 97 patients.\(^{106}\) There was no significant difference in dietary intake and exercise scores between overweight and non-overweight schizophrenics either.

Reversing the view, Loo et al. surveyed 102 overweight or obese (BMI >23 kg/m\(^2\)) patients referred for dietary advice to a dietician clinic and found using the 30 question General Health Questionnaire that 15.7% had psychiatric illness.\(^{107}\) Abdollahi and Abu Talib also showed that obese individuals with sedentary behaviour and poor body esteem were more likely to show social anxiety.\(^{108}\)

A study on whether stress and depression had a causal link to abdominal obesity across 17 countries, in which Malaysia was included, found that stress and depression had no independent effect on abdominal obesity.\(^{109}\)

Night eating syndrome (NES) describes a condition characterised by morning anorexia, evening hyperphagia and insomnia. Nocturnal food ingestion is >50% of daily calories intake and occurs at least three times a week for a period of three months. Ainsah and Osman reported the case of a 65-year-old Malay widower, whose wife and son had earlier left him; a retired army sergeant, with multiple medical problems and was chronically feeling depressed. He was morbidly obese with a BMI of 45 kg/m\(^2\) and had problems with excessive weight gain since the age of 41 years. He responded to diet and behaviour therapy and reduced his weight from 123kg to 91kg over 18 months.\(^{110}\)

**Pregnancy Induced Hypertension**

In a small case-control study of 30 cases attending antenatal clinic matched with controls in the three selected health centres in Alor Gajah, Melaka, Adinegara and Razzak found that pregnancy induced hypertension (PIH) was significantly associated with obesity and being a housewife. However, there was no association at all between consumption of the varied food items and the development of PIH.\(^{111}\)

**Spontaneous Cerebrospinal Fluid Rhinorrhoea**

Gendeh and Salina reported clinical data of eight patients diagnosed with spontaneous cerebrospinal fluid rhinorrhoea who had been treated at their tertiary referral centre between 1998 and 2007 and noted all of them were overweight (mean BMI 32.5 kg/m\(^2\)) seven out of the eight were female. Central obesity raises intra-abdominal and intrathoracic pressure, increasing the cardiac-filling pressure which in turn impedes the venous return from the brain leading to raised intracranial pressure. Obese patients are also more prone to exaggerated oscillations in intracranial pressure and therefore more at risk of developing a CSF leak.\(^{112}\)

**Breast Cancer**

Three studies have examined the nutritional status of breast cancer patients.\(^{113,114,115}\) Norsa’adah et al. noted that 48% of their women with breast cancer in Kelantan were overweight/obese and they thought that the rate was higher than the general population, compared to the NHMS II data.\(^{116}\) However, in view of the general rise in prevalence of obesity of that period around the year 2000, that may not be true.

A case-control study of breast cancer patients in Kuala Lumpur matched for their age and menopausal status with volunteers at the National Cancer Society in 2006 found that 71% of breast cancer patients had a waist circumference >80 cm compared to 40% among controls. Premenopausal breast cancer patients were four times more likely to have abdominal obesity.\(^{117}\)

Yong et al. found that in the year preceding diagnosis of breast cancer women on average lost weight (mean loss=0.7 kg).\(^{118}\) However after diagnosis till the time of study these women had a mean gain in weight of 3.5 kg. Less than 20% of women actually lost weight with their encounter with breast cancer. Excluding those who lose weight on account of advanced breast cancer, women tend to over compensate nutritionally in the course of having breast cancer. Lua et al. found that 70% of their breast cancer patients were meeting more than their individual daily energy requirements.\(^{119}\) However, only 31.7% achieved the recommended daily intake of fruits and vegetable.
Colorectal Cancer
Metabolic syndrome, of which obesity is a factor is a known risk factor for colorectal cancer and affirmed in Malaysia.\textsuperscript{114} It has also been suggested that obesity is a risk factor for colorectal adenoma. In a case-control study of 59 patients with colorectal adenomas matched with controls, waist circumference was the only factor that was found to significantly increase the risk for colorectal adenoma, and only in women. A waist circumference of >88 cm carried a six-fold increased risk of having an adenoma.\textsuperscript{111}

Chronic Periodontitis
Obesity has been identified as a risk factor of chronic periodontitis (CP). A study using convenience sampling of 165 participants from various clinics in University Malaya Medical Centre, above 30 years old and with a BMI >27.5kg/m\textsuperscript{2} found that 73.9% had CP; 55% of them moderate or severe CP.\textsuperscript{116}

MANAGING OBESITY
Recognising the seriousness and magnitude of the growing problem of obesity, Clinical Guideline for the Management of Obesity were drawn up together and published by the Ministry of Health, the Academy of Medicine and several specialist medical societies under the chairmanship of Ikram SI in 2004. In addition to defining the problem, the document recommended strategies for weight loss. It outlined dietary therapy as well as physical therapy. It discussed the role of pharmacotherapy and surgery. It also acknowledges the role of counselling and behaviour therapy.\textsuperscript{117} The Malaysian Association for the Study of Obesity in Malaysia also produced a document on strategies to prevent obesity in 2005 under the chairmanship of Mohd Ismail N. Besides elucidating the role of diet and physical activity, the report recognised that managing obesity was a shared responsibility involving government, industry, professional bodies, non-governmental organisations, communities and individuals. It proposed that a National Steering Committee for the Prevention of Obesity be established. It recommended that working groups be formed in communities, schools, health care facilities and workplaces to educate the population and take action.\textsuperscript{118}

Behavioural Factors
Poh\textit{ et al.} found that working women in Kuala Lumpur were fairly knowledgeable concerning healthy body weight management. They found no difference between the normal weight and overweight women. School teachers were significantly more knowledgeable than civil servants in weight management matters. More overweight women (20%) had high knowledge level scores (75%) compared to normal weight women (15%).\textsuperscript{119}

The management of obesity is intricately intertwined with behavioural change. Besides a minor role for medication and surgery, the mainstay of weight reduction is modification of dietary intake and physical activity. In a study of native Sarawakians living in villages who were overweight or obese, Chang found that 76.8% perceived that they were overweight/obese. As regards behaviour change, 60.5% (164/271) were in the pre-contemplation stage, which means they were not even thinking of behaviour change. The commonly used Transtheoretical Model of change (TTM), views change as a process that involves five stages. Pre-contemplation is the first stage. Contemplation is the second stage, where an individual is considering change within the next six months. 20.7% (56/271) of the overweight native Sarawakian villagers were in that stage. The remaining 18.9% (51/271) were in either the preparation stage (intending to take action within 30 days), the action stage (overt modification of behaviour of less than six months duration) or maintenance phase (behaviour change longer than six months). A higher level of education was the only factor that correlated with a higher level of preparedness for behavioural change.\textsuperscript{120} On the other hand, in a survey of university staff across the spectrum of weight distribution, done as a baseline for behaviour intervention, Ang \textit{et al.} found that 50.7% (172/339) were in the preparation stage for change; 30.0% (101/337) were either in the action or maintenance stage of change, 14.5% (49/337) were in the contemplation stage and only 5.0% (17/337) were in pre-contemplation.\textsuperscript{121}

Intervention Programmes
Moy \textit{et al.} conducted an intervention programme involving Malay male security guards working in a public university in Kuala Lumpur, of whom 34% were overweight. The group received intensive individual and group counselling on diet, physical activity and quitting smoking, but they found at the end of two years there was no change in the BMI of the group.\textsuperscript{122} Ramli \textit{et al.} reported a six-month-long obesity health programme/study, which consisted of two weekly unsupervised exercise sessions and monthly dietary/health education sessions, conducted among overweight civil servants during office hours. Unfortunately, there was no significant change in body weight, although the subject did show some improvement in indices of physical fitness.\textsuperscript{123} Al-Qalah \textit{et al.} surveyed 639 Malaysian working women in Putrajaya and Bangi to identify those who had successfully lost weight. Successful weight loss was defined as losing at least 10% of their highest lifetime body weight. They found 18.8% (120/639) experienced successful weight loss. The commonest dietary weight loss strategy used was to eat more fruits and vegetables (50.8%), followed by reducing the amount of food eaten (49.2%) and reducing fatty food intake (42.5%).\textsuperscript{124}

A total of 28 obese (BMI >30 kg/m\textsuperscript{2}) subjects at Obesity Clinic, Hospital Universiti Sains Malaysia, Kelantan completed a 12-week weight loss programme consisting of dietary and exercise interventions. There was a significant mean weight change from 89.27±2.78 kg to 83.11±2.42 kg. Four subjects (14.3%) lost more than 10% of their body weight. There was also a significant reduction of waist circumference, BMI and fat-free mass. The investigators also found a significant decline in the levels of plasminogen activator inhibitor (PAI-1), plasminogen activator (t-PA) levels, thrombin activatable fibrinolytic inhibitor (TAFI) and fibrinogen alongside the weight reduction. They noted a significant correlation between BMI with fibrinogen and all three fibrinolytic markers suggesting a beneficial effect of this program on the haemostatic burden particularly on the fibrinolytic biomarkers.\textsuperscript{125}
Suri ani et al. investigated two dietary control programmes for overweight and obese women in Putrajaya and Seremban. The first was a standard programme promoting food quantity control based on the national dietary guidelines. The faith-based programme, in addition contained relevant Islamic information to motivate participants. 84 Malay Muslim women chose the former and 56 chose the latter. The programme began with Ramadan and continued for three months after Ramadan. At that point in time, the mean BMI reduction in the standard dietary intervention was 0.16 kg/m² (from 31.14±4.26 kg/m² to 30.98±4.28 kg/m²; p = 0.16; CI: -0.06 to 0.38) while it was 0.49 kg/m² in the faith-based dietary intervention group (from 31.01±4.07 kg/m² to 30.52±4.03 kg/m²; p ≤0.01; CI: 0.22 to 0.75).126,127,128

Teng et al. investigated the weight reduction effects of caloric restriction combined with two days a week of Muslim Sunnah fasting in a 12-week trial, among Malay men who had BMI between 23.0-29.0 kg/m². The 28 men in the intervention group, who were provided food guidelines, log books and contact once a week, reduced caloric intake from a mean of 1707 kcal by about 60 kcal. DNA damage, assessed by the alkaline comet assay and fluorescence microscopy decreased significantly in the intervention group, as did oxidative stress measured by plasma malondialdehyde.129

In a small study of 25 obese patients, Christopher et al. noted that a period of supervised regular exercise improved pulmonary function of obese patients and independent of the amount of weight loss.130

The Malaysian Health Promotion Board funds projects run by non-governmental organisations, such as Komuniti Sihat Perkasa Negara (KOSPEN), Healthy Eating Campaigns, Nutrition Month campaigns, Ruzita et al. evaluated the effectiveness of 22 such projects on obesity conducted in the year 2010 by examining their final reports. 18 projects were of less than three months duration and four longer than three months. They judged 21 project to be of moderate quality and one of poor quality based on their achievement in health literacy.131

In previous times and cultures being ‘plump’ or ‘chubby’ may have been perceived positively. However as in most cultures today, being obese is perceived negatively in Malaysia.132 Action for weight loss is popular among the general population, even among the normal weight, and not only the obese. 37.7% of 1032 people surveyed in shopping centres in Kuala Lumpur admitted they have taken such action before. Only 32.6% of them were actually overweight or obese. 50.4% of those who have attempted to lose weight mistakenly perceived their weight category. The normal and underweight tend to be lower in weight than they imagined, while the overweight and obese tended to be heavier than they perceived. Dieting (89.5%) and exercise (81%) were the most popular weight loss measures, followed by slimming teas (24.9%), vitamins (21.9%) and chitosan (19.0%).133

**Pharmaceutical Agents**

Surya and Azmawati found that 41.6% (62/149) of overweight and obese (149/258) university students surveyed used non-prescription substances for weight loss management.134

Liraglutide an analogue of Glucagon-like peptide-1 (GLP-1), stimulates insulin secretion, inhibits appetite centres in the brain as well as delays gastric emptying. It is used in the management of type 2 diabetes as well as obesity management. In a randomised controlled trial of 44 obese binge eaters divided into two groups for 12 weeks, Robert et al. found participants who received liraglutide in addition to diet and exercise, showed significant improvement in binge eating, accompanied by reduction in body weight (94.54±18.14 kg to 90.14±19.70 kg, p < 0.001), BMI (36.15±3.84 kg/m² to 34.40±4.77 kg/m², p < 0.001), and waist circumference (103.9±13.7 cm to 100.2±14.0 cm, p < 0.004). On the other hand, the control group showed slight but not significant changes in these parameters.135

Robert et al. studied the effect of untreated fenugreek (halba in Malay) seed powder (5.5g) on a small sample (n=14) of overweight and obese individuals and reported that it decreased the post-prandial glycaemic response and increased satiety.136

Sibutramine is a serotonin-noradrenaline reuptake inhibitors (SNRI) related to amphetamines that suppresses appetite and is a prescribed weight reduction agent. It has been withdrawn in several countries due to concerns regarding its cardiovascular effects. A case of non-ischemic dilated cardiomyopathy in a man who lost approximately 10 kg in total in four months has been reported locally.137

**BIOMARKERS**

Although over-eating and under-exercising are the main drivers for obesity, the physiological trigger to stop eating, that one might expect to govern this, appears not to be effective enough to overcome the tendency for humans to deviate from the ideal healthy body weight. The satiety effect of homeostatis is not coping with the socio-economic success that has produced abundance of food supply. Understanding the genes and biological pathways that control eating behaviour may provide a key to managing obesity.

A vast array of genes and their products including adiponectin, β2-adrenoreceptor (ADRB2), carnitine palmitoyltransferase-1 (CPT1), cholecystokinin, fat mass and obesity associated (FTO), ghrelin, glucagon-like-peptide-1 (GLP1), insulin-induced gene 2 (INSIG2), leptin, long-chain fatty acyl-coenzyme A (LCFA-CoA), melanoctin-4-receptor (MC4R), N-acylphosphatidylethanolamine (NAPE), neuropeptide Y (NPY), oleoylthanolamide (OEA), oxyntomodulin (OXM), peptide YY (PYY), resistin, syndecan 3 (SDC3), and others act on the gut or brain to promote either anorexia or satiety. Many of these biomarkers may be
associated with obesity related traits, even if they are not significantly associated with obesity itself measured by BMI.

In addition, inflammation, indicated by its various markers such as C-reactive protein, tumour necrosis factor and others also affect metabolism and obesity. Gut microbiota also plays a role.

Leptin is a satiety signal. Fan and Say investigated the prevalence of the leptin genes LEP(A19G) and LEP(G2548A) single nucleotide polymorphisms (SNPs) and the leptin receptor genes LEPR(K109R) and (Q223R) SNPs. The prevalence of the variant allele of the genes were 0.74, 0.67, 0.61 and 0.79 respectively. Indians had the lowest rates of the variant genes and Chinese had the highest. The variant genes were not associated with obesity, but the LEPR (109R) SNP (rs1137100) variant was protective against obesity and subjects with the variant had lower plasma leptin levels than their wild-type allele counterparts. Chinese had the highest frequency of the variant. Apalasamy also found blood adiponectin levels associated with obesity related traits, even if they are not significantly associated with obesity itself measured by BMI.

The Fatty Acid Binding Protein2 (FABP2) is associated with obesity. FABP2 (Ala54Thr), was significantly associated with obesity among Indians (n=146), but not Chinese (n=133) and Malays (n=161). Apalasamy also found blood adiponectin levels associated with obesity, but resistin appeared to have less effect on obesity. Adiponectin levels in blood are highly associated with the ADIPOQ gene. Apalasamy found a significant association between the ADIPOQ (rs17366568) gene variant and obesity among Malays. The frequencies of AG and AA genotypes were significantly higher in the obese group (11%) than in the non-obese group (5%). However, no significant association was found between allelic frequencies of the ADIPOQ gene. Apalasamy found no association was found between allelic frequencies of the ADIPOQ (rs3774261) variant gene.

The melanocortin-4 receptor (MC4R) mediates the effects of leptin in its anorexigenic pathway, and a defective gene that fails to suppress appetite is associated with obesity. Chua et al. found only a 0.02 frequency (10/498) of the Valine-Isoleucine variant (V103I) of the MC4R among subjects in Kampar and no significant difference related to obesity measurements. Apalasamy et al. found no significant association of the SNPs variants of MC4R; (rs571312), (rs2229616), (rs7227255) with obesity, even though the (rs571312), (rs2229616) SNPs were associated with obesity related parameters. Apalasamy also found blood adiponectin levels associated with obesity, but resistin appeared to have less effect on obesity. Adiponectin levels in blood are highly associated with the ADIPOQ gene. Apalasamy found a significant association between the ADIPOQ (rs17366568) gene variant and obesity among Malays. The frequencies of AG and AA genotypes were significantly higher in the obese group (11%) than in the non-obese group (5%). However, no significant association was found between allelic frequencies of the ADIPOQ gene. Apalasamy found no association was found between allelic frequencies of the ADIPOQ (rs3774261) variant gene.

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The insulin-induced gene 2 (INSIG2) plays a role in cholesterol metabolism, lipogenesis, and glucose homeostasis and studies have shown that INSIG2 polymorphisms were associated with obesity and weight gain. However, Apalasamy et al. found no significant association between the (rs7566605) tagging SNP of INSIG2 with obesity or other metabolic parameters in the Malaysian Malay population.

Peptide Tyrosine-Tyrosine (PYY) is a hormone released in the intestinal tract to suppress pancreatic secretions and eventually reduce appetite. The R72T variant in the PYY gene (rs1058046) has been associated with increased susceptibility to obesity. Chan et al. found a 0.45 frequency for the variant T allele among 197 subjects in Kampar. Indians had the highest rates of the T allele (61.3%) and Chinese the lowest (32.5%). The rate in Malays was 49.3%. They found no association of genotype with obesity measured by BMI, but the TT genotype was associated with a higher waist circumference and visceral fat level.

B2-Adrenergic receptors (ADRB2) play a role in blood pressure regulation, lipoprotein metabolism, energy expenditure and hence obesity. Apalasamy et al. however found the gene variant ADRB2 (A19G) SNP (rs1042714), not significantly associated with BMI among Malays.

Osteocalcin, an osteoblast-specific protein, is a marker of bone formation but also influence body fat. Lack of osteocalcin has been associated with obesity. Chin et al. demonstrated that serum osteocalcin level was significantly associated with obesity and serum HDL cholesterol level in a sample of 373 Malaysian men.

Oxidative stress is induced in obesity. It is present when there is an imbalance between the antioxidant defence system and free radical production. Plasma total antioxidant
capacity (TAC) is a biomarker derived to assess cumulative action of all the antioxidants present in plasma. Lim et al. measured the Trolox equivalent antioxidant capacity (TEAC) among 362 Malaysian subjects and determined that it was significantly associated with obesity.154

The soluble form of the urokinase plasminogen activator surface receptor (suPLAUR) enhances leukocyte migration and adhesion, and its circulatory level is increased in inflammatory states. Of three variants, Ng et al. found that only suPLAUR (transcript variant 2) increases in omental adipose tissues in obese individuals, suggesting it has a role recruiting immune cells to adipose tissue in the pathogenesis of obesity.155

Peroxisome proliferator-activated receptors (PPARs) are nuclear receptor proteins that play a role in the expression of genes that regulate metabolism. Chia et al. found none of the SNPs of PPAR they investigated were associated with obesity and Met-S in the suburban population of Kampar, Malaysia.156

The uncoupling proteins (UCP) 1-3 are mitochondrial inner membrane proteins that can dissipate the proton gradient before it can be used to provide the energy. Lee et al. found that Chinese with the T allele of the UCP3-55C/T single nucleotide polymorphism had significantly lesser risk to be centrally obese (OR=0.69).157

**SECTION 2: RELEVANCE OF FINDINGS FOR CLINICAL PRACTICE**

It is clear that the effort to combat the high prevalence of obesity has been and is a national priority and resources must be allocated appropriately.158 The Ministry of Health may educate and counsel its patients and contacts in all its health facilities and designate various professions, from doctor to nurses and dieticians to different roles in the course of regular work. It may also consider strategic programmes and campaigns. However, the national effort must be wider than that. Non-governmental organisation, schools, other government agencies and bodies, corporate firms, and community associations and societies and even religious groups can raise awareness as well as run programmes. This can be done when they are given motivational and technical assistance. The need is to educate the masses about what constitute healthy living and probably the mass media is the most powerful channel today. Radio, television, magazines and the internet have the most penetrating reach into all strata of society. Health is for all and proper nutrition is truly a matter in which every individual is a stakeholder.

The two main areas for action are food intake and physical activity. The low education and low income segment of the population need to be taught how to eat healthily and if they have issues concern access to such food, they should be given assistance. Housewives are obviously the key target population. They are not only one of the most obese occupational group, they control how the rest of the family eats. They should be taught what foods to buy and how many calories each meal should contain. The marketing and advertisement of cheap unhealthy food should be addressed.

**SECTION 3: FUTURE RESEARCH DIRECTION FOR OBESITY IN MALAYSIA**

The prevalence of obesity in Malaysia has been fairly well established by numerous studies over the past decade but this should be followed up with well-timed surveys to monitor the changing trends. Prevalence studies in special groups should only be done and interpreted with reference to the overall data and have a clear interest, such as to identify groups with a particularly high prevalence and risk factors or problems such as dual malnutrition which require targeted intervention.

Alongside the programmes to manage obesity research needs to be conducted to monitor the outcome of obesity reduction programmes.

The MASO identified several areas of research needs in their report. They included measures for prevention of overweight and obesity in the local situation. They mentioned studies to determine the environmental, behavioural, social and ecological factors that contribute to obesity in different segments of the population. They listed studies to assess the economic burden of overweight and obesity in the population and behavioural research to identify culturally appropriate techniques to motivate people to increase and maintain physical activity and make healthier food choices. They also listed research on the influence of marketing practices in food industry and food outlets and cost-effectiveness of community-directed measures to prevent and manage overweight and obesity. The report also mentioned the need to assess community insights in relation to their understanding, perceptions, and expectations on weight maintenance.119

Childhood obesity, which is outside the scope of this review also needs to be addressed, and the school setting plays an important role.

Researchers in Malaysia should keep abreast with new findings about biomarkers and where relevant study the significance of these biomarkers in our population.

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