REVIEW ARTICLE

Are Malaysians Getting Fatter and Rounder?: An Updated Systematic Review (2009 – 2015)

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ABSTRACT

Overweight and obesity have become a serious health issue in worldwide and Malaysia is no exception. In view that obesity is one of the leading causes of non-communicable diseases, this systematic review aimed to explore whether Malaysian are getting fatter (overweight or obesity) and rounder (abdominal obesity). Searches of the published literature were conducted using 3 databases including EMBASE, MEDLINE, and PubMed. These were limited to cross-sectional or cohort studies in Malaysia. The databases provided the prevalence of overweight, obesity, and abdominal obesity among 15 years old and above Malaysian population from 2009 to 2015. In total, 47 articles were included in this review. Findings exhibit that the prevalence rates of overweight, obesity, and abdominal obesity range from 9.5% to 43.5%, 1.77% to 26.4% and 11.4% to 57.4%, respectively. Overweight is more predominant among males. However, obesity and abdominal obesity are more predominant among females. This means that more females are getting fatter and "rounder" as compared to males in Malaysia. The findings imply a lack of intervention programmes based on proper randomized controlled trials which are needed to adequately address the problem of obesity in Malaysia.

Keywords: Overweight, Obesity, Abdominal obesity, Malaysia, Prevalence

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INTRODUCTION

According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that pose a risk to health. Body mass index (BMI) is a crude population measure of obesity. BMI of $25\,\mathrm{kgm^{-2}}$ or more is classified as overweight, while BMI equal or more than $30\,\mathrm{kgm^{-2}}$ is classified as obesity (1). Individuals with overweight or obesity are at greater risk for mortality than their underweight counterparts (2).

Worldwide, more than 1.9 billion adults aged 18 years old and above were overweight in 2014. Out of these, there were 600 million obese adults. In other words, the prevalence of overweight among adults was 39% (2). As far as gender is concerned, the prevalence of overweight was higher among women (40%) compared

to men (38%) (2). The prevalence of obesity was also higher among women (15%) compared to men (11%) (2). From 1980 and 2014, the obesity's prevalence increased more than double worldwide (2). Prevalence of overweight and obesity were also high in low-and middle-income countries, especially in urban areas (2).

Among United States adults, the abdominal obesity's overall adjusted-prevalence was 46.4% in 1999 - 2000, and this figure increased significantly to 54.2% in 2011 – 2012 (3). This prevalence was based on a waist circumference (WC) cut-off of > 102cm for males and > 88cm for females (3). For China, the total age-adjusted prevalence among adults was 44.0% based on a WC cut-off of ≥ 90cm for males and ≥ 80cm for females according to WHO recommendations for Asians (4). Thai medical students showed 13.0% of abdominal obesity with the same cut-off for Asians (5).

The objective of this systematic review was to determine the prevalence and trend of overweight, obesity, and abdominal obesity in Malaysia (2009 to 2015). Also, to compare the prevalence of overweight, obesity,

and abdominal obesity between sexes, and to extend Khambalia and Seen (2010)'s comprehensive review in the last decade (1996 - 2009) (6). This review is important to update public health professionals, policy makers, doctors, scholars, and the community for identifying and recognizing the escalating trend of body weight issues and their associations with the development of non-communicable diseases (NCDs) in Malaysia.

MATERIALS AND METHODS

Inclusion/ exclusion criteria and search strategy

Only cross-sectional and cohort studies conducted in Malaysia were included in this review. The expected outcome was to review the prevalence of overweight or/ and obesity or/ and abdominal obesity (also called as central obesity) among 15 years old and above Malaysian population. Specific disease in the population, review articles, posters, unpublished data, and other study designs were excluded from this review.

Malaysia, located in Southeast Asia, is divided into two parts: Peninsular Malaysia and East Malaysia. These two parts are separated by the South China Sea. Malaysia has a total land area of 328,550 square kilometres (7). Malaysia consists of 13 states (i.e., Perlis, Kedah, Penang, Perak, Selangor, Negeri Sembilan, Melaka, Johor, Pahang, Kelantan, Terengganu, Sabah, and Sarawak) and three federal territories (Wilayah Persekutuan (WP) Kuala Lumpur, WP Putrajaya, and WP Labuan). The national language in Malaysia is Malay. Malaysia's geographic map is shown in Figure 1.
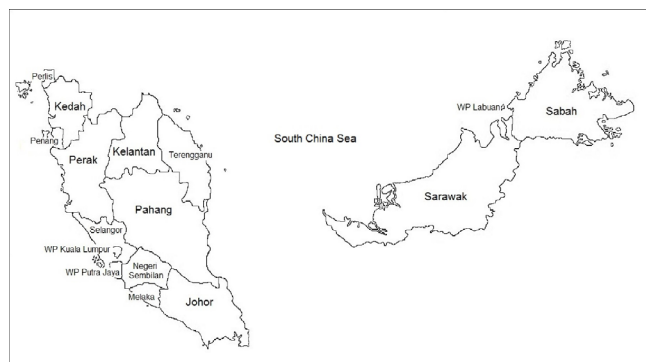

Figure 1: Geographic map of Malaysia
WP: Wilayah Persekutuan (Federal Territory)

Previous studies were identified by searching EMBASE, MEDLINE, and PubMed. The search strategies were developed with the assistance of a medical information specialist. EMBASE and MEDLINE were searched via Ovid SP and PubMed on 27th February 2015 limiting the search to published literature in English between 2005 and search date. This Boolean search was used and published elsewhere (8). Keywords were collected through controlled vocabulary (Medical Subject Headings = MeSH and Excerpta Medica Tree = EMTREE).

Initially, only articles published from 1st January 2005 to 27th February 2015 were included in this review. During the screening process, a comprehensive review (6) which included published articles from 1996 to 2009 in Malaysia on the same topic was found (6). To avoid redundancy, only articles published from 2009 to 27th February 2015 were selected.

Selection of studies

The titles and abstracts of articles were independently screened by the two main authors. Then, the full text of each article that fulfilled the inclusion criteria was retrieved and independently reviewed by the two main authors again. In an attempt to achieve final consensus, each of them compiled a list of studies. Disagreements, if any, were resolved by discussion.

Quality Assessment

Scores on the articles' quality were assessed based on the criteria as follows (6): A score of 1 for national representative studies, random sampling, and large sample size. A score of 2 for an entire state involved, random sampling, and large sample size. A score of 3 for a specified number of units being randomly sampled. A score of 4 for large sample sizes (more than 1,000 participants) regardless sampling method. A score of 5 for small sample sizes and non-random sampling. The higher the score, the less quality it was, or vice versa.

RESULTS

One hundred and ninety-five articles were obtained from EMBASE, 374 articles from MEDLINE, and 134 articles from PubMed, totalling 703 articles. There were 159 duplicates; therefore, only 544 articles were available for screening purposes. After screening for title and abstract appropriateness, 43 out of 544 articles were selected for this review. Four additional articles were identified from the list of references of the selected articles. Ultimately, 47 articles were included in this review. In accordance with the PRISMA, the process of articles selection is shown in Figure 2.

Out of 47 selected studies, there were 10 studies with a score of 1 (9-18). Thirteen studies were classified as medium quality (a score of 3) (19-31). Three studies obtained a score of 4 (32-34) and 21 studies obtained a score of 5 (35-55).

The study characteristics and review outcomes of the selected studies are presented in Table I and Table II, respectively. The study population included three age groups: group 1 (age ranged from 15 years old and above; hereafter referred to as general population; 29 studies) (9-14, 17-22, 26, 27, 29, 30, 32-34, 37, 39, 41, 43, 44, 48, 50, 53-55), group 2 (age ranged from 18 to 27 years old; hereafter referred to as undergraduate students; 11 studies) (23-25, 28, 31, 35, 36, 38, 40, 46, 49), and group 3 (age ranged from 40 years old and
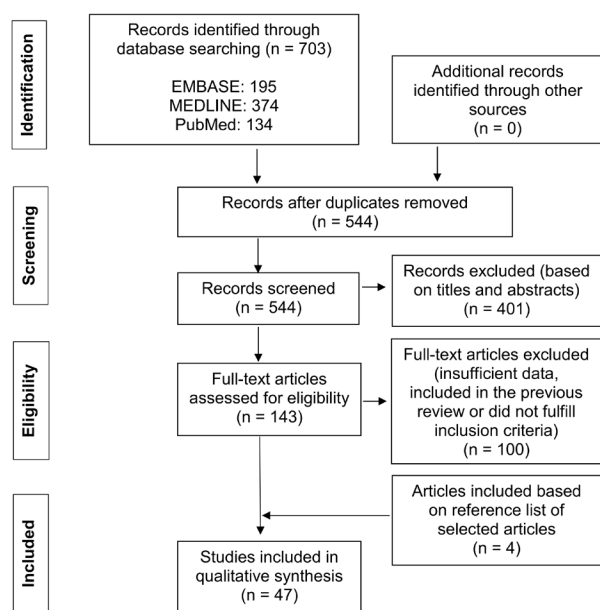
Figure 2: PRISMA flow diagram of articles selection for present systematic review

above; hereafter referred to as a group of 40 years old and above; 7 studies) (15, 16, 42, 45, 47, 51, 52).

Prevalence of overweight and obesity
BMI was defined in different ways as reported in the selected studies. However, as recommended by WHO (1990, 1995, 1998, and 2000), BMI between 25.0kgm^{-2} to 29.9kgm^{-2} was classified as overweight and BMI equal or more than 30kgm^{-2} was classified as obesity (56-59).

The prevalence rates of overweight (BMI 25.0kgm^{-2} to 29.9kgm^{-2}) in the selected studies ranged from 27.6% (29) to 43.5% (32) for the general population; the prevalence rates ranged from 9.5% (23) to 12.9% (35) for undergraduate students. Under this BMI classification, three studies recruited a group of 40 years old and above. The prevalence rate of overweight ranged between 29.8% (16) to 37.0% (52) for this age group. For example, in one study, it was found that 46% of 125 post-menopausal Malay females aged from 50 to 65 years old were overweight (42).

In the case of general population, males showed higher prevalence of overweight than females. For males, the prevalence ranged from 29.8% (43) to 48.2% (39). For females, the prevalence ranged from 24.7% (55) to 35.0% (44). However, in a study by Haemamalar et al., indigenous females (28.6%) showed higher prevalence of overweight than indigenous males (10.3%) (41). Like general population, male undergraduate students showed higher prevalence of overweight than female undergraduates. The prevalence of overweight among

male students ranged from 11.0% (23) to 18.9% (35); whereas the prevalence of overweight among female undergraduate students ranged from 6.11% (25) to 8.5% (23, 24). Older male adults were less overweight (36.6%) as compared to older female adults (44.1%) (16). In contrast, Rosnah et al.'s study showed that prevalence of overweight among elderly males (39.5%) was higher than elderly females (33.7%). Such a finding could be due to unequal sample characteristic - more male participants were recruited (52).

With respect to obesity, the prevalence rates were ranged from 12.4% (33) to 26.4% (39) in the general population, from 1.77% (25) to 3.4% (23) in undergraduate students, and from 10.8% (16) to 17.4% (52) in the group of 40 years old and above.

As far as gender is concerned, the prevalence of obesity ranged from 16.1% (22) to 31.2% (39) among females and from 14.1% (10) to 21.2% among males (43). For male undergraduates, the prevalence of obesity ranged from 3.0% (23) to 4.9% (35). For female undergraduates, the prevalence ranged from 0.56% (25) to 3.8% (23). As reported in a few national studies, females were more obese as compared to males (10, 16, 18, 20, 22, 23, 39, 52). Only five studies reported otherwise (25, 35, 40, 41, 43). The findings were unequivocal in part due to sample characteristics.

Prevalence of abdominal obesity
WHO (1998 & 2000) suggests cut-off points of waist circumference (male ≥ 102cm; female ≥ 88cm) for determining abdominal obesity (58, 59). From the selected studies, only one study used such cut-off points (16). The findings from a nationwide household survey indicated that the overall prevalence of abdominal obesity among 4,746 older people (aged 60 and above) was 21.4%. The prevalence of abdominal obesity was more predominant in females (33.4%) than in males (7.7%) (16).

According to World Health Organization/ International Association for the Study of Obesity/ International Obesity Task Force, WHO/ IASO/ IOTF (2000) (60) and International Diabetes Federation, IDF (2006) (61), a WC of ≥ 90cm for male, and ≥ 80cm for female in the context of Asian population was classified as abdominal obesity. These cut-off points were widely used in the selected studies. The prevalence of abdominal obesity among the general population ranged from 36.9% (13) to 57.4% (9). For undergraduate students, the prevalence of abdominal obesity ranged from 11.4% (23) to 18.1% (36). In one study, 21.4% of females had abdominal obesity; however, surprisingly no males had abdominal obesity even though gender distribution of the sample was almost equal (41). Across studies, females had higher prevalence of abdominal obesity than males, except for one study (43).

Table I: General description of selected studies (2009 – February 2015)

Quality assessment (Score)	Author(s), year	Study location	Study duration	Study population (included sample size)	Age (years)	Sampling technique	Weight	Height	Waist circumference
1	Mohamud et al., 2012 (9)	1 urban and 1 rural from each states/ zones (Johor, Kelantan, Penang, Sabah and Selangor)	January - December 2008	4,341 adults (35.1% male and 64.9% female)	≥ 18	Two-stage stratified sampling, households were randomly selected. Participants selected based on World Health Survey Kish table.	-	-	Tape (nearest 0.1 cm)
1	Mohamud et al., 2011 (10)	1 urban and 1 rural from each states/ zones (total of 5)	2007 - 2008	4,341 adults (35.1% male and 64.9% female)	≥ 18	Two-stage stratified sampling, households were randomly selected. Participants selected based on World Health Survey	Digital scale (nearest 0.1 kg)	Same tool for weight measurement (nearest millimeter)	-
1	Nuur Amalina et al., 2012 (11)	States included Perlis, Kedah, Penang, Perak, Selangor, Wilayah Persekutuan (WP) Kuala Lumpur, Negeri Sembilan, Melaka, Johor; Pahang, Kelantan, Terengganu, Sabah, Sarawak, WP Labuan	2006	32,796 adults (44.6% male and 55.4% female)	> 20	National Health and Morbidity Survey (NHMS) III - Multi-stage stratified sampling proportionate to population size	-	-	SECA 200 measuring tape (nearest 0.1 cm)
1	Phipps et al., 2015 (12)	Belum, Gua Musang, Carey Island, Cameron Highlands, Tasik Chini, Batu Bakar, Gelang Patah and Kuala Masai	-	636 indigenous (43.2% male and 56.8% female)	≥ 18	Comparable to National Health and Morbidity Survey (NHMS) III	-	-	-
1	Rampal et al., 2012 (13)	All states	2004	17,211 residents (42.4% male and 57.6% female)	≥ 15	Stratified two-stage cluster sampling	-	-	SECA® measuring tape (Germany)
1	Selvarajah et al., 2012 (14)	2,150 Enumeration Blocks, consists of 17,251 living quarters	2006	34,505 participants (44.8% male and 55.2% female)	≥ 18	National Health and Morbidity Survey (NHMS) III - Two-stage stratified random sampling proportionate to population size	-	-	SECA® measuring tape (Germany)
1	Selvarajah et al., 2014 (15)	2,150 Enumeration Blocks, consists of 17,251 living quarters	2006	14,863 participants (45.3% male and 54.7% female)	40 – 65	National Health and Morbidity Survey (NHMS) III - Two-stage stratified random sampling proportionate to population size	TANITA digital lithium weighing scale (Tokyo, Japan)	SECA 206 portable body meter (Hamburg, Germany)	-
1	Suzana et al., 2012 (16)	Households in 17,200 living quarters, all states	April – July 2006	4,746 older people (46.6% male and 53.4% female)	≥ 60	National Health and Morbidity Survey (NHMS) III - Two-stage random sampling proportionate to the size of population throughout states	TANITA 318 digital lithium weighing scale (Japan) (nearest 0.1 kg)	SECA 206 portable body meter (Germany) (nearest 0.1 cm)/ half arm span	SECA® measuring tape (Germany) (nearest 0.1 cm)
1	Tan et al., 2012 (17)	13 states and federal territory (Kuala Lumpur)	September 2005 – February 2006	2,436 respondents (41.3% male and 58.7% female)	25 – 64	Data from Malaysia Non-Communicable Disease Surveillance (MyNCDS) -1 Report of Ministry of Health (2005)	Balance beam/ SECA beam scale	Stadiometer	-
1	Zaki et al., 2010 (18)	93 public/ private primary care clinics (multi-centre) in 14 states	22 – 23 June 2005	1,893 patients (52.5% male and 47.5% female)	> 18 - < 80	Malaysia Shape of the Nation (MySoN) - Clinics were stratified by states, based on the size of the population to obtain a number of clinics in each state. Clinics were recruited by simple random sampling.	Bathroom spring balance (nearest 0.1 kg)	Measuring tape (nearest 0.1 cm)	Measuring tape
3	Amiri et al., 2014 (19)	833 households in Lembah Pantai area, Kuala Lumpur	February - November 2012	1,096 adults (43.7% male and 56.3% female)	≥ 18	Simple random sampling to select from 4,726 households	SECA 813 Digital High Capacity Floor Scale (nearest 0.1 kg)	SECA 217 Stadiometer (nearest 1 mm)	-
3	Chang et al., 2012 (20)	269 households from 2 Malay villages (rural community), Serian district, Sarawak	-	260 participants (34.6% male and 65.4% female)	20 – 65	Stratified proportionate fixed random sampling (randomly select from 8 villages)	SECA weighing scale (Japan) (nearest 0.1 kg)	SECA body meter (Japan) (nearest 0.1 cm)	-

(table continues)

Table I: General description of selected studies (2009 – February 2015) (*continued*)

Quality assessment (Score)	Author(s), year	Study location	Study duration	Study population (included sample size)	Age (years)	Sampling technique	Weight	Height	Waist circumference
3	Cheah et al., 2011 (21)	3 villages (Kampung Baru, Kampung Buntal and Kampung Pangkalan Kuap) consisted 238 rural households from 2 divisions (Kuching and Samarahan), Sarawak	2007	238 respondents (46.5% male and 53.5% female)	≥ 16	2 divisions were selected, after that randomly selected a district from both divisions. From each district, randomly selected 5 villages, finally 3 villages agreed to participate.	SECA digital weighing scale (United Kingdom)	SECA body meter (United Kingdom)	-
3	Cheong et al., 2010 (22)	6 faculties from a public university in Selangor	January – June 2008	367 fulltime employees (39.2% male and 60.8% female)	20 - 61	6 faculties randomly selected from all (n = 14) faculties, then randomly select participants (n = 465)	TANITA model 309 electronic weighing scale	SECA model 208 body meter	-
3	Gan et al., 2011 (23)	4 universities in Klang Valley (field of study: art, technical and science)	October – December 2009	584 university students (40.6% male and 59.4% female)	18 – 24	Multistage stratified (field of study) random sampling (one faculty from each field). Participants were voluntarily.	TANITA Digital Weight Scale HD306 (United States of America) (nearest 0.1 kg)	SECA Body Tape Measure SE206 (Germany) (nearest 0.1 cm)	SECA Ergonomic Circumference Measuring Tape SE203 (Germany) (nearest 0.1 cm)
3	Hossain et al., 2013 (24)	University of Malaya (UM), Kuala Lumpur	July 2010-April 2011	961 female university students	18 - 25	Stratified random sampling with proportional allocation	Weighing scale	Anthropometer	-
3	Huda and Ahmad, 2010 (25)	Universiti Sains Malaysia (USM), main campus in Minden, Penang	-	624 university students (42.3% male and 57.7% female)	18 - 26	Data were randomly collected	Bathroom scale	Commercial tape	-
3	Jamal et al., 2015 (26)	Urban: private/ government office, housing areas, towns, cities. Rural: the government's Federal Land Development Authority (FELDA)	April 2006 – end of September 2012	106, 527 individuals (42.2% male and 57.8% female)	35 - 70	The Malaysian Cohort (TMC) Project -Voluntary participation, cluster and targeted sampling for rural area.	SECA weighing scale	Harpenden stadiometer	-
3	Mohamadpour et al., 2012 (27)	Households in 7 palm-plantation (Tanah Merah, Tampin Linggi, Sengkang, Ladang Labu, Ladang P. D., Lukut Siliau, Bukit Pelandok), Negeri Sembilan	March – August 2007	147 Indian females	19 – 49	Randomly selected households	TANITA weighing scale	SECA body meter	SECA body meter
3	Moy et al., 2009 (28)	A public university, Kuala Lumpur	March – May 2003	2,665 undergraduate students (43.5% male and 56.5% female)	Mean: 21.7 ± 2.8	5,000 questionnaires distributed to all faculties (sampling ratio: 1 out of 4 undergraduate), proportionate sampling was used within each faculty to sample various years of undergraduate.	-	-	-
3	Mustafa et al., 2013 (29)	6 primary care clinics in Suburban District, Hulu Langat, Selangor	June – August 2010	254 employees (22.0% male and 78.0% female)	≥ 18	Stratified sampling to select from 9 clinics	SECA scale	Body meter	-
3	Shariff et al., 2014 (30)	625 households from urban and rural area from 3 states (Negeri Sembilan, Kelantan and Selangor)	July 2005 – December 2009	625 females (low cost communities)	19 - 49	Purposive sampling low-income households of Malay and Indian. Households were randomly selected.	-	-	SECA measuring tape
3	Yeng and Sedek, 2012 (31)	8 faculties, Universiti Kebangsaan Malaysia (UKM), Bangi, Selangor	January – February 2012	200 undergraduate students (50% male and 50% female)	20 - 25	Random sampling	TANITA digital balance HD312 (Japan) (nearest 0.1 kg)	SECA body meter 208 (Germany) (nearest 0.1 cm)	-
4	Amplavanar et al., 2010 (32)	Health Clinic in Batu 9, Cheras, Selangor	March 2002 - June 2008	3,772 adults (64.7% male and 35.3% female)	≥ 30	Secondary data on participants who joined cardiovascular disease screening program	Electronic floor weighing scale (nearest 0.1 kg)	SECA fixed stadiometer (Vogel & Halke, Germany) (nearest centimeter)	-
4	Ong et al., 2013 (33)	All states	17 December 2007 – 30 August 2009	40,400 public adults (50.6% male and 49.4% female)	≥ 18	Public adults were invited for National Kidney Foundation (NKF) Lifecheck Health Screening programme	-	-	-

(*table continues*)

Table I: General description of selected studies (2009 – February 2015) (*continued*)

Quality assessment (Score)	Author(s), year	Study location	Study duration	Study population (included sample size)	Age (years)	Sampling technique	Instrument		
							Weight	Height	Waist circumference
4	Rasiah et al., 2013 (34)	Community centres in rural and urban area (Selangor, Kuala Lumpur, Negeri Sembilan, Pahang, Kelantan, Sabah)	2007 - 2010	11,959 adults (43.8% male and 56.2% female)	≥ 30	Volunteers who participated a community-based health survey organized by REDIS-COVER (Responding to Increasing Cardiovascular Disease Prevalence)	-	-	-
5	Boo et al., 2010 (35)	International Medical University, IMU (Malaysian private medical school)	July – September 2008	240 medical students (50.8% male and 49.2% female)	Semester 6 – 9 (Age not stated)	All medical students (n = 307) were invited	SECA Medical weighing scale (Bradford, Massachusetts, United States of America)	SECA Medical measuring rod (Bradford, Massachusetts, United States of America) (nearest 0.5 cm)	-
5	Chan et al., 2014 (36)	University of Malaya (UM)	-	469 medical students (40.3% male and 59.7% female)	Mean: 23.2 ±2.4	Volunteer participation	Standardized equipment	Standardized equipment	-
5	Chew et al., 2014 (37)	Suburban (Klang Valley, Seri Kembangan New Village, Selangor)	August – September 2011	258 Chinese residents (53.7% male and 60.5% female)	21 - 60	Convenience sampling to select participants	MS-3400 PIR weighting machine (MARSDEN, Taiwan) (nearest 0.1 kg)	Height rod attached to MS-3400 PIR weighting machine (MARSDEN, Taiwan) (nearest 0.1 cm)	SECA non-extendable measuring tape (Hamburg, Germany) (nearest 0.1 cm)
5	Choong et al., 2012 (38)	Universiti Tunku Abdul Rahman (UTAR), Perak Campus	-	300 Malaysian university students (38% male and 62% female)	Mean: 20.90 ±1.67	Convenience sampling to select participants	Salter Body Analyzer and Scale, United Kingdom (nearest 0.25 kg)	Meterstick that fixed to wall (nearest 0.1 cm)	-
5	Chu and Moy, 2013 (39)	A public university, Kuala Lumpur	August 2010 – August 2011	686 Malay employees (39.7% male and 60.3% female)	≥ 35	Participants who joined annual health screening in university	SECA digital scale	SECA stadiometer (Hamburg, Germany)	Circumference measuring tape
5	Gopalakrishnan et al., 2012 (40)	AIMST University	-	290 medical students (45.2% male and 54.8% female)	19 - 25	All (n = 420) students were invited	Standardized weighing machine	Measuring scale	-
5	Haemamalar et al., 2010 (41)	26 Che Wong households from Krau Wildlife Reserve at Southern Pahang (Kg. Bancal, Kg. Bayek, Kg. Bayek Neram, Kg. Beranti, Kg. Bess, Kg. Enggang, Kg. Kalau, Kg. Sabut, Kg. Senel, Kg. Sungai Enggang)	-	57 indigenous (50.9% male and 49.1% female)	≥ 18	Purposive sampling in all households (n = 45), but only 26 households participated.	TANITA weighing scale	SECA body meter	SECA measuring tape
5	Hasnah et al., 2012 (42)	Low cost houses [Bandar Tun Razak, Kuala Lumpur City Hall flats (Sri Kota, Sri Labuan and Sri Melaka), Taman jaya] in Cheras, Kuala Lumpur	-	125 post-menopausal (at least 2 years) Malay females	50 - 65	Convenience sampling	SECA digital weighing scale (Germany) with height attachment	SECA digital weighing scale (Germany) with height attachment	-
5	Hazizi et al., 2012 (43)	17 departments from Federal Government Building Penang	May – July 2009	233 Malay government employees (44.6% male and 55.4% female)	18 - 59	Invited 20 departments to join, 17 permitted, all employees were invited to join.	TANITA Body Composition Analyser TBF-306 (Japan)	SECA Body Meter (Vogel & Halke GmbH & Co., Germany) (nearest 0.1 cm)	Unstretchable measuring tape
5	Ihab et al., 2013 (44)	8 largest villages in Bachok district, Kelantan	-	223 household (mothers)	18 - 55	Purposive selection on villages, non-probability sampling to select participants	SECA digital weighing scale (nearest 0.1 kg)	SECA portable body meter (precision of 0.1 cm)	Flexible tape (precision of 0.1 cm)
5	Johari and Shahar, 2014 (45)	Low cost flats (urban area in the central of Malaysia)	December 2008 – May 2009	343 elderlies (39.4% male and 60.6% female)	≥ 60	Volunteer participation	TANITA digital lithium scale HD319 weighing scale (Tokyo, Japan) (nearest 0.1 kg)	Leicester Height Measure (CMS Weighing Equipment, United Kingdom) (nearest 0.1 cm)	-
5	Kuan et al., 2011 (46)	Universiti Malaysia Sarawak (UMS)	September 2008 – mid-November 2008	600 undergraduate students (50% male and 50% female)	-	Convenience sampling to select participants	Analog weighing scale (Camry, Malaysia) (nearest 0.5 kg)	1.50 m measuring tape (Goldfish Brand, China) (nearest 0.01 m)	-

(table continues)

Table I: General description of selected studies (2009 – February 2015) (*continued*)

Quality assessment (Score)	Author(s), year	Study location	Study duration	Study population (included sample size)	Age (years)	Sampling technique	Instrument		
							Weight	Height	Waist circumference
5	Lee et al., 2012 (47)	15 public flats, Kuala Lumpur City Hall, Cheras, Selangor	December 2008 – May 2009	318 elderly subjects (40.9% male and 59.1% female)	≥ 60	Volunteers recruitment	TANITA HD-319 digital bathroom scale (Japan) (nearest 0.1 kg)	Leicester Height Measure (CMS Weighing Equipment, United Kingdom) (nearest 0.1 cm)	-
5	Liau et al., 2010 (48)	Engineering campus, Universiti Sains Malaysia (USM)	19 February – 12 March 2009	217 employees (57.6% male and 42.4% female)	22 - 64	All employees from this campus were invited for screening	Electronic scale	Vertical stadiometer	-
5	Liew et al., 2009 (49)	Kolej and Universiti Tunku Abdul Rahman (2 private institutions), Setapak, Kuala Lumpur	October – December 2008	200 Malaysian college/ university healthy students (42.5% male and 57.5% female)	Mean: 21.22 ± 2.85	Random convenience sampling	Salter Body Analyzer and Scale (United Kingdom)	Measuring tape	-
5	Lim et al., 2012 (50)	Kampar Health Clinic, Perak	April - December 2010	362 subjects (38.1% male and 61.9% female)	21 – 80	Convenience sampling to recruit participants	OMRON HBF-362 Karada scan bioimpedance scale (Japan)	Measuring tape (nearest 0.1 cm)	-
5	Mohamad et al., 2010 (51)	Low cost flats at urban area, Cheras, Kuala Lumpur	September 2008 – January 2009	112 elderly Malay residents (41.1% male and 58.9% female)	≥ 60	Invited all participants, convenience sampling	TANITA digital lithium scale HD319 (Tokyo, Japan)	SECA Leicester Portable Height Measure (Humberg, German)	SECA measuring tape (Humberg, German)
5	Rosnah et al., 2009 (52)	Institute of Gerontology, Universiti Putra Malaysia (UPM)	-	230 older Malaysians (56.1% male and 43.9% female)	≥ 60	Body dimensions obtained from a study named "An Elderly Friendly Housing Environment for Older Malaysians"	-	-	-
5	Saibul et al., 2009 (53)	182 households from 14 villages of 2 districts (Sepang and Carey Island), Selangor	2002 - 2005	182 indigenous females	18 – 55	All households (n = 339) were screened and 227 households were eligible, but only 182 households participated.	TANITA digital weighing scale (Tokyo, Japan) (nearest 0.1 kg)	SECA body meter (Vogel and Halke Gmgh & Co., Hamburg, Germany) (precision of 0.1 cm)	-
5	Saw et al., 2012 (54)	Dental clinic, Universiti Kebangsaan Malaysia (UKM)	-	168 adult patients (30.4% male and 69.6% female)	20 – 59	Patients who attended dental clinic were invited	OMRON Karada Scan model HBF-356 (nearest 0.1 kg)	SECA 206 Body Meter Scale (nearest 0.1 cm)	-
5	Siti Affira et al., 2011 (55)	4 private companies, Petaling Jaya, Selangor	-	215 working females	18 – 55	Purposive sampling. Randomly selected 10 companies from a list of corporate companies (n = 100), where 4 companies agreed to participate. Respondents participated voluntarily.	TANITA digital weighing scale model 314 (nearest 0.1 kg)	SECA wall stadiometer model 206 (nearest 0.1 cm)	SECA non-elastic measuring tape (nearest 0.1 cm)

DISCUSSION

In Malaysia, two national population-based surveys were available: The National Health and Morbidity Surveys (NHMS) and the Malaysian Adult Nutrition Survey (MANS). Using stage stratified sampling method, the NHMS 1996, 2006, 2011, and 2015 recruited adults aged 18 years old and above (62-65), whereas MANS 2003 and 2014 recruited adults aged 18 to 59 years (66, 67). The BMI classification for both the NHMS and MANS was based on WHO 1995 and 1998 (a BMI score between 25.0 to 29.9 was classified as overweight, whereas a BMI score of 30.0 and above was classified as obesity) (62-67). According to these Malaysian national population-based surveys, the prevalence of overweight was 16.6% in 1996, and the prevalence continued to increase to 26.7% in 2003, to 29.1% in 2006, to 29.4% in 2011, and to 32.4% in 2014 (62-64, 66, 67). Like overweight, the prevalence of obesity exhibited an increasing trend. In 1996, the prevalence of obesity was 4.4%, and the prevalence continued to increase to 12.2% in 2003, to 14.0% in 2006, to 15.1% in 2011, and to 18.5% in 2014 (62-64, 66, 67). According to the latest NHMS (2015) findings, there was a slight decrease: the prevalence was 30.0% for overweight and 17.7% for obesity (65). Abdominal obesity increased from 17.4% in 2006, to 20.9% in 2011, to 20.0% in 2014, and to 23.0% in 2015 (63-65, 67). Among the Southeast Asian population, Malaysian adults have been reported to have the highest prevalence of overweight (44.2%) and obesity (14.0%), followed by Thailand (overweight: 32.2%; obesity: 8.8%) and Singapore (overweight: 30.2%; obesity: 7.1%) (68). This increasing trend of overweight and obesity in Malaysia has been attributed to the economic growth, industrialization, urbanization (lacking of activity and sedentary lifestyle), globalization, and westernization (fast food consumption) over the past decade (2, 6).

Table II: Prevalence of overweight, obesity and abdominal obesity of selected studies (2009 – February 2015)

Quality assessment (Score)	Author(s), year	Study population and sample size	Age (years)	Prevalence of Overweight (%)				Prevalence of Obesity				Body Mass Index (BMI) Criteria	Prevalence of Abdominal/ Central Obesity				Waist Circumference (WC) criteria
				Definition based on BMI (kg/m²)	Male	Female	Total	Definition based on BMI (kg/m²)	Male	Female	Total		Definition based on WC (cm)	Male	Female	Total	
1	Mohamud et al., 2012 (9)	4,341 adults (35.1% male and 64.9% female)	≥ 18	-	-	-	-	-	-	-	-	-	Male: ≥ 90 Female: ≥ 80	44.9 (42.4, 47.4)	64.2 (62.4, 66.0)	57.4 (55.9, 58.9)	WHO/ IASO/ IOTF, 2000
1	Mohamud et al., 2011 (10)	4,341 adults (35.1% male and 64.9% female)	≥ 18	25.0 – 29.9	34.4 (32.0, 36.9)	33.1 (31.4, 34.9)	33.6 (32.2, 35.0)	≥ 30	14.1 (12.3, 15.9)	22.5 (20.9, 24.0)	19.5 (18.3, 20.7)	WHO, 1995	-	-	-	-	-
1	Nuur Amalina et al., 2012 (11)	32,796 adults (44.6% male and 55.4% female)	> 20	-	-	-	-	-	-	-	-	-	Male: ≥ 90 Female: ≥ 80	-	-	40.9	IDF, 2006
1	Phipps et al., 2015 (12)	636 indigenous (43.2% male and 56.8% female)	≥ 18	-	-	-	-	> 30	-	-	16.8 (13.8, 19.8)	-	Male: > 90 Female: > 80	-	-	38.4 (35.0, 41.8)	-
1	Rampal et al., 2012 (13)	17,211 residents (42.4% male and 57.6% female)	≥ 15	-	-	-	-	-	-	-	-	-	Male: ≥ 90 Female: ≥ 80	28.0 (0.6)	45.8 (0.6)	36.9 (0.5)	Alberti et al., 2009
1	Selvarajah et al., 2012 (14)	34,505 participants (44.8% male and 55.2% female)	≥ 18	-	-	-	-	-	-	-	-	-	Male: ≥ 90 Female: ≥ 80	28.6 (26.0, 31.4)	45.7 (44.4, 47.0)	37.2 (35.4, 39.0)	IDF, 2006
1	Selvarajah et al., 2014 (15)	14,863 participants (45.3% male and 54.7% female)	40 – 65	23.5 < BMI < 25	44.1	37.3	40.4	≥ 25	25.3	37.5	32.0	-	-	-	-	-	-
1	Suzana et al., 2012 (16)	4,746 older people (46.6% male and 53.4% female)	≥ 60	25.0 – 29.9	36.6 (34.5, 38.8)	44.1 (42.1, 46.1)	29.8 (28.4, 31.2)	≥ 30	7.4 (6.4, 8.6)	13.8 (12.5, 15.2)	10.8 (9.9, 11.7)	WHO, 1995	Male: > 102 Female: > 88	7.7 (6.7, 9.0)	33.4 (31.4, 35.5)	21.4 (20.2, 22.6)	WHO, 1998
1	Tan et al., 2012 (17)	2,436 respondents (41.3% male and 58.7% female)	25 – 64	25.0 – 29.9	-	-	31.5	≥ 30	-	-	17.2	WHO/ IASO/ IOTF, 2000	-	-	-	-	-
1	Zaki et al., 2010 (18)	1,893 patients (52.5% male and 47.5% female)	> 18 - < 80	25 – 29.9	36.41	32.22	34.20	≥ 30	16.59	23.94	20.43	WHO, 2000	Male: ≥ 90 Female: ≥ 80	48.05	62.44	55.60	WHO/ IASO/ IOTF, 2000
3	Amiri et al., 2014 (19)	1,096 adults (43.7% male and 56.3% female)	≥ 18	23.0 – 24.9	-	-	14.4	≥ 25.0	-	59.3	54.8	WHO Expert Consultation, 2004	-	-	-	-	-
3	Chang et al., 2012 (20)	260 participants (34.6% male and 65.4% female)	20 – 65	25 – 29.9	-	-	39.6	≥ 30	4.0 (0.1 – 8.8)	15.9 (10.3 – 21.4)	11.9	Obesity and overweight, 2009	-	-	-	-	-

(table continues)

Table II: Prevalence of overweight, obesity and abdominal obesity of selected studies (2009 – February 2015) (*Continued*)

Quality assessment (Score)	Author (s), year	Study population and sample size	Age (years)	Prevalence of Overweight (%)				Prevalence of Obesity				Body Mass Index (BMI) Criteria	Prevalence of Abdominal/ Central Obesity				Waist Circumference (WC) criteria
				Definition based on BMI (kg/m²)	Male	Female	Total	Definition based on BMI (kg/m²)	Male	Female	Total		Definition based on WC (cm)	Male	Female	Total	
3	Cheah et al., 2011 (21)	238 respondents (46.5% male and 53.5% female)	≥ 16	-	-	-	-	≥ 25	-	-	49.0	WHO/IASO/IOTF, 2000	-	-	-	-	-
3	Cheong et al., 2010 (22)	367 fulltime employees (39.2% male and 60.8% female)	20 - 61	25-29.9	31.9	26.5	28.6	≥ 30	16.0	16.1	16.1	-	Male: ≥ 90 Female: ≥ 80	36.8	39.0	38.1	-
3	Gan et al., 2011 (23)	584 university students (40.6% male and 59.4% female)	18 - 24	25.00 – 29.99	11.0	8.5	9.5	≥ 30	3.0	3.8	3.4	WHO, 2000	Male: ≥ 90 Female: ≥ 80	11.0	11.7	11.4	WHO/IASO/IOTF, 2000
3	Hossain et al., 2013 (24)	961 female university students	18 - 25	25 - < 30	-	8.5	-	≥ 30	-	3.1	-	Flegal et al., 2005	-	-	-	-	-
3	Huda and Ahmad, 2010 (25)	624 university students (42.3% men and 57.7% female)	18 - 26	25.0 – 29.9	14.39	6.11	9.61	≥ 30	3.41	0.56	1.77	WHO, 1990	-	-	-	-	-
3	Jamal et al., 2015 (26)	106,527 individuals (42.2% male and 57.8% female)	35 - 70	-	-	-	-	-	-	-	17.7	–	-	–	-	-	-
3	Mohamadpour et al., 2012 (27)	147 Indian females	19 – 49	≥ 25	-	64.6	-	-	-	-	-	-	≥ 88	-	34.0	-	NIH, 2002
3	Moy et al., 2009 (28)	2,665 undergraduate students (43.5% male and 56.5% female)	Mean: 21.7 ±2.8	Overweight	-	-	7.8	-	-	-	-	-	-	-	-	-	-
3	Mustafa et al., 2013 (29)	254 employees (22.0% male and 78.0% female)	≥ 18	25 - 29.9	-	-	27.6	≥ 30	-	-	18.5	WHO, 2000	-	-	-	-	-
3	Shariff et al., 2014 (30)	625 females (low cost communities)	19 - 49	-	-	-	-	-	-	-	-	-	≥ 80	-	39.7	-	Alberti et al., 2009
3	Yeng and Sedek, 2012 (31)	200 undergraduate students (50% male and 50% female)	20 - 25	-	24.0	10.0	17.0	-	10.0	9.0	9.5	WHO Expert Consultation, 2004	-	-	-	-	-
4	Amplavanar et al., 2010 (32)	3,772 adults (64.7% male and 35.3% female)	≥ 30	25 – 29.99	-	-	43.5	≥ 30	-	-	19.1	-	-	-	-	-	-

(table continues)

Table II: Prevalence of overweight, obesity and abdominal obesity of selected studies (2009 – February 2015) (*Continued*)

Quality assessment (Score)	Author(s), year	Study population and sample size	Age (years)	Prevalence of Overweight (%)				Prevalence of Obesity				Body Mass Index (BMI) Criteria	Prevalence of Abdominal/ Central Obesity				Waist Circumference (WC) criteria
				Definition based on BMI (kg/m²)	Male	Female	Total	Definition based on BMI (kg/m²)	Male	Female	Total		Definition based on WC (cm)	Male	Female	Total	
4	Ong et al., 2013 (33)	40,400 public adults (50.6% male and 49.4% female)	≥ 18	-	-	-	-	≥ 30	-	-	12.4	NCEP, 2002	-	-	-	-	-
4	Rasiah et al., 2013 (34)	11,959 adults (43.8% male and 56.2% female)	≥ 30	≥ 25	28.4	34.5	31.8	-	-	-	-	WHO website, assessed 2012	-	-	-	-	-
5	Boo et al., 2010 (35)	240 medical students (50.8% male and 49.2% female)	Semester 6 – 9 (Age not stated)	25 – 29.9 (pre-obese)	18.9	6.8	12.9	≥ 30	4.9	1.7	3.3	WHO	-	-	-	-	-
				23 – 27.4 (pre-obese)	31.1	16.9	24.2	≥ 27.5	9.0	2.5	5.8	WHO for Asian					
5	Chan et al., 2014 (36)	469 medical students (40.3% male and 59.7% female)	Mean: 23.2 ±2.4	-	-	-	-	≥ 25	-	-	14.5	Anurad et al., 2003	Male: >90 Female: >80	-	-	18.1	Alberti et al., 2005
5	Chew et al., 2014 (37)	258 Chinese residents (53.7% male and 60.5% female)	21 - 60	23.00 -24.99	-	-	21.0	≥ 25.00	39.2	40.4	39.9	WHO/IOTF/IASO, 2000	Male: ≥ 90 Female: ≥ 80	-	-	41.5	-
5	Choong et al., 2012 (38)	300 Malaysian university students (38% male and 62% female)	Mean: 20.90 ±1.67	≥ 23	33.3	22.6	26.7	-	-	-	-	WHO/IOTF/IASO, 2000	-	-	-	-	-
5	Chu and Moy, 2013 (39)	686 employees (39.7% male and 60.3% female)	≥ 35	25 – 29.9	48.2	33.3	39.2	≥ 30	19.1	31.2	26.4	WHO, 1998	Male: >90 Female: >80	41.5	62.8	54.4	Moy & Bulgiba, 2010
5	Gopalakrishnan et al., 2012 (40)	290 medical students (45.2% male and 54.8% female)	19 – 25	25.0 – 29.9	18.3	13.8	15.9	≥ 30	9.2	1.9	5.2	Shashikiran et al., 2004	-	-	-	-	-
5	Haemamalar et al., 2010 (41)	57 indigenous (50.9% male and 49.1% female)	≥ 18	25 – 29.9	10.3	28.6	19.3	≥ 30	3.3	0.0	1.8	WHO, 1995	Male: ≥ 90 Female: ≥ 80	0.0	21.4	10.5	IOTF/WHO/IASO, 2000
5	Hasnah et al., 2012 (42)	125 post-menopausal (at least 2 years) Malay females	50 - 65	25 - 29.9	-	46	-	≥ 30	-	31	-	WHO, 1995	-	-	-	-	-
5	Hazizi et al., 2012 (43)	233 Malay government employees (44.6% male and 55.4% female)	18 - 59	25 - 29.9	29.8	29.5	29.6	≥ 30	21.2	20.1	20.6	WHO 1995	Male: ≥ 90 Female: ≥ 80	49.0	45.7	47.2	-

(*table continues*)

Table II: Prevalence of overweight, obesity and abdominal obesity of selected studies (2009 – February 2015) (*Continued*)

Quality assessment (Score)	Author(s), year	Study population and sample size	Age (years)	Prevalence of Overweight (%)				Prevalence of Obesity				Body Mass Index (BMI) Criteria	Prevalence of Abdominal/ Central Obesity				Waist Circumference (WC) criteria
				Definition based on BMI (kg/m²)	Male	Female	Total	Definition based on BMI (kg/m²)	Male	Female	Total		Definition based on WC (cm)	Male	Female	Total	
5	Ihab et al., 2013 (44)	223 household (mothers)	18 - 55	25 – 29.9	-	35.0	-	≥ 30	-	17.0	-	WHO	≥ 80	-	47.1	-	WHO, 1998
5	Johari and Shahar, 2014 (45)	343 elderlies	≥ 60	≥ 23	59.3	60.1	-	-	-	-	-	WHO Expert Consultation, 2004	-	-	-	-	-
5	Kuan et al., 2011 (46)	600 undergraduate students (50% male and 50% female)	-	≥ 23	34.0	22.0	28.0	-	-	-	-	Clinical Practice Guidelines on Management of Obesity, 2004	-	-	-	-	-
5	Lee et al., 2012 (47)	318 elderly subjects (40.9% male and 59.1% female)	≥ 60	Overweight/ obesity	57.7	63.3	61.0	-	-	-	-	Fidanza & Keller., 1991	-	-	-	-	-
5	Liau et al., 2010 (48)	217 employees (57.6% male and 42.4% female)	22 - 64	23.0 – 27.4	-	-	40	≥ 27.5	-	-	33.3	Clinical Practice Guidelines on Management of Obesity, 2004	-	-	-	-	-
5	Liew et al., 2009 (49)	200 Malaysian college/ university healthy students (42.5% male and 57.5% female)	Mean: 21.22 ± 2.85	-	-	-	-	≥ 27	32.9	25.2	28.5	Deurenberg-Yap et al., 2000	-	-	-	-	-
5	Lim et al., 2012 (50)	362 subjects (38.1% male and 61.9% female)	21 – 80	-	-	-	-	≥ 27	40.6	50.9	47.0	Deurenberg-Yap et al., 2000	-	-	-	-	-
5	Mohamad et al., 2010 (51)	112 elderly Malay residents (41.1% male and 58.9% female)	≥ 60	≥ 25	-	-	62.5	-	-	-	-	WHO, 1998	-	7.1	41.8	26.8	-
5	Rosnah et al., 2009 (52)	230 older Malaysians (56.1% male and 43.9% female)	≥ 60	25.0 – 29.9	39.5	33.7	37.0	≥ 30	10.1	26.7	17.4	WHO	-	-	-	-	-
5	Saibul et al., 2009 (53)	182 indigenous females	18 – 55	25.0 – 29.9	-	31.3	-	≥ 30	-	19.8	-	WHO, 1995	-	-	-	-	-
5	Saw et al., 2012 (54)	168 adult patients (30.4% male and 69.6% female)	20 – 59	≥ 25	-	47.0%	-	-	-	-	-	-	-	-	-	-	-
5	Siti Affira et al., 2011 (55)	215 working females	18 – 55	25.00 – 29.99	-	24.7	-	≥ 30	-	7.9	-	WHO, 2000	≥ 80	-	34.0	-	WHO/ IASO/ IOTF, 2000

The prevalence of overweight among the Malaysian general population from the selected studies in this present review (27.6% to 43.5%) was comparable to the NHMS 2015 (65). This finding is similar for the group of 40 years old and above participants but not for undergraduate students. Less undergraduate students were found to be overweight.

The NHMS 2014 showed that age group was a significant risk factor of overweight. The prevalence of overweight was 22.3% for the group aged from 20 to 29 years, 32.7% for the group aged from 30 to 39 years, 39.3% for the group aged from 40 to 49 years, and 43.5% for the group aged from 50 to 59 years. The age group with the highest prevalence of overweight was from 50 to 54 years old (39.3%), based on the NHMS 2015 (65, 67). Most of the studies included in this present review showed that males had higher prevalence of overweight as compared to females. The same pattern of results was obtained in the NHMS 2015 (65).

For socio-demographic background, the results from this review showed that more obese females were found as compared to obese males. Consistent with the NHMS 2014, females (22.9%) had higher prevalence rate of obesity than males (14.5%) (67). Also consistent with the NHMS 2015, females (20.6%) had higher prevalence rate of obesity than males (15.0%) (65). According to NHMS 2014, as for ethnicity, the prevalence rate of obesity was 28.1% for Indians, 22.0% for Malays, 17.0% for Bumiputera Sarawak. Significant differences in terms of prevalence of obesity between Chinese and Indians and between Bumiputera Sabah and Indians were reported by the same survey (65, 67). Indians showed the highest prevalence of obesity, 27.1% based on NHMS 2015 (65). Among the ethnic groups, Indians reported to have taken less fruits and vegetables in their diet, besides being physically inactive (69). Taken together, the results from NHMS 2014 were comparable to the NHMS 2015 in that the prevalence of obesity were associated with sociodemographic variables (65, 67).

Based on a WC cut-off of > 102cm for males and > 88cm for females, the prevalence of abdominal obesity was 20.0% in the NHMS 2014. As reported in the NHMS 2011 and 2014, gender and ethnicity were significant risk factors for abdominal obesity. The prevalence rate of abdominal obesity was 50% for group aged from 40 to 59 years old (64, 67). The prevalence of abdominal obesity among the general population in this present review ranged from 36.9% (13) to 57.4% (9). The present results are comparable to the NHMS 2011 (43.0%) as indexed by a cut-off of ≥ 90cm for males and ≥ 80cm for females. Like previous national population-based surveys, the findings from this review reported that females were found to have abdominal obesity (63-65, 67).

High prevalence of obesity among Malaysian adults could lead to NCDs such as cardiovascular diseases, type II diabetes mellitus, and even cancers (64, 70). For obese people, they were not only at risk for psychological distress such as depression and anxiety but also for suicidal behaviour (64, 71-74). In worldwide, the BMI increased since 1975 and if the trend continues to rise, there is no chance in meeting the target of global obesity (75, 76). It warrants prevention and intervention efforts in combating the increasing trends of overweight, obesity, and abdominal obesity in a new decade. In the process of conducting this systematic review, it was noted that obesity reduction programmes with a design of randomized controlled trials are scant. Therefore, the findings from this review provide insights into the need for effective obesity reduction programs targeting public health action and policy enhancement.

The challenge of conducting this review was the lack of a standardised measure for assessing outcome variables (e.g., cut-off points for BMI and WC). The issue of incomplete data concerning BMI's and WC's cut-off points, study duration, age range of respondents, and instruments used for anthropometry measurements (weight, height, and waist circumference) should be also noted. Forty-seven articles were included in this intensive review, hinting the issue of obesity is becoming a matter of great concern. Meta-analysis was not performed in this review due to the heterogeneity of studies such as inconsistent terminologies for defining body weight status and abdominal obesity. There was also variation in terms of study population, sample sizes, age ranges, setting, and instruments.

CONCLUSION

The prevalence rates of overweight, obesity, and abdominal obesity are high and show an increasing trend. Overweight is more predominant among males. However, obesity and abdominal obesity are more predominant among females. This means that more females are getting fatter and "rounder" as compared to males in Malaysia. Based on the findings of this review, there is an urge to call for randomized controlled trials on obesity reduction programmes in Malaysia since obesity can lead to NCD and complications. It may also be worthwhile to design separate interventions for males and females, since there were differences in the prevalence among them.

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