PREVALENCE OF OVERWEIGHT AND OBESITY IN MALAYSIA, 2010 - 2016: A COMPREHENSIVE META-ANALYSIS

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Abstract. Prevalence of overweight and obesity in Malaysia has been reported in numerous studies, but with inconsistent findings, and no meta-analysis has been conducted to evaluate the findings of these studies. This meta-analysis investigated the prevalence of overweight and obesity in Malaysia based on independent observational studies from 2010 to 2016. Systematic literature search was performed in PubMed database based on inclusion and exclusion criteria. Heterogeneity for each subgroup analysis was determined using I^2 index and Q-test. Funnel plot as well as Begg's and Egger's tests were employed to evaluate publication bias. Following a detailed assessment, 18 eligible studies involving 20,751 subjects were included in the meta-analysis. All pooled prevalence rates were determined using random effect model based on significance of heterogeneity observed (I^2>80% and p<0.001). Overall, the prevalence rates of overweight and obesity in Malaysia was 25.0% and 13.1%, respectively. When stratified to gender, prevalence of overweight and obesity was higher in females than in males. No publication bias was identified.

Keywords: obesity, overweight, meta-analysis, prevalence, Malaysia

INTRODUCTION

Overweight and obesity are encountered in more than 1.9 billion adults globally (WHO, 2017). An individual is classified as overweight when the body mass index (BMI) is 25.0-29.9 kg/m^2 and obese when the BMI is ≥30.0 kg/m^2 (WHO, 1995). The National Health and Morbidity Survey 2015 reported nearly half of the Malaysian population are overweight and/or obese (MIPH, 2015), and Malaysia has been named as having the highest rate of overweight and obesity among all Southeast Asian countries (WHO, 2011). This unpromising situation should be seriously monitored as overweight and obesity often are present together with systemic, low-grade and chronic inflammation usually associated with numerous life-threatening diseases (Rodríguez-Hernández *et al*, 2013; Segula, 2014).

The prevalence of overweight and obesity in Malaysia has been reported by numerous independent observation studies across different states of the country, but the findings are inconsistent. Moreover, there is no meta-analysis conducted to evaluate the findings of these studies on trends in prevalence of overweight and

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obesity in recent years. Hence, a meta-analysis was performed to investigate the prevalence of overweight and obesity in Malaysia based on previous studies reported in PubMed database from 2010 to 2016.

MATERIALS AND METHODS

Literature search and selection

A comprehensive literature search was carried out in the PubMed database using the following keywords: "prevalence", "overweight", "obesity", and "Malaysia" for publications from 1 January 2010 until 31 December 2016. Inclusion criteria were (i) observational peer-reviewed studies that clearly stated the number of overweight and obese subjects and (ii) subjects categorized using BMI following the WHO international standard (WHO, 1995). Exclusion criteria were (i) use of existing/published data for analysis, (ii) use of different standards to categorize subjects as overweight and obese and (iii) no differentiation between the numbers of overweight and obesity. In order to avoid duplication, only studies with the most recent data were included in the meta-analysis.

Data extraction

Data including first author's name, publication year and number of subjects for both overweight and obese were extracted from all included studies. Data extraction was performed by two independent investigators and disagreements were clarified through discussion. The work flow is depicted in Fig 1.

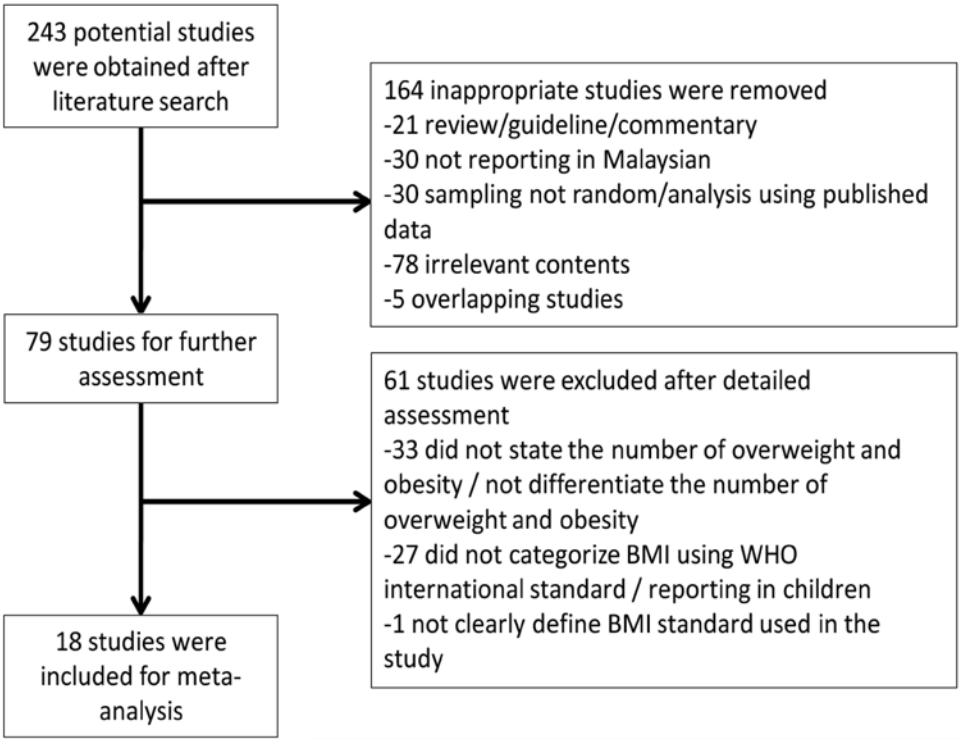

Fig 1-Flow diagram of systemic literature search in the meta-analysis.

Statistical analysis

Prevalence rate with 95% confidence interval (95% CI) of overweight and obesity was calculated using Comprehensive Meta-Analysis Ver. 2.2.064 (Biostat, Englewood, NJ). I^2 (represented by percent value) and Q (represented by a p-value) statistical tests were used to determine the heterogeneity of each subgroup. If $I^2 < 50\%$ and p-value ≥ 0.10, a fixed effect model is used to calculate the pooled prevalence rate (Mantel and Haenszel, 1959), whereas a random effect model is used to calculate the pooled prevalence rate if $I^2 > 50\%$ and p-value < 0.10 (DerSimonian and Laird, 1986). Publication bias was determined using a funnel plot supported with Begg's (Begg and Mazumdar, 1994) and Egger's (Egger *et al*, 1997) statistical tests, and a p-value < 0.05 is considered indicative of publication bias.

RESULTS

Publications selected

A total of 18 observation studies with 20,751 subjects were incorporated in this meta-analysis after detailed assessment of records in PubMed database from 2010 to 2016: 3, 1, 4, 1, 3, 2, and 4 in 2010, 2011, 2012, 2013, 2014, 2015, and 2016, respectively (Table 1). Among all studies ($n = 18$) examined, five reported overall prevalence of overweight and obesity without specific data for gender and three only reported prevalence of overweight and obesity in females, and therefore were excluded in the overall subgroup analyses to avoid bias in the interpretation of results.

Prevalence of overweight and obesity

Prevalence rates of overweight and obesity in all subgroup analyses were calculated using the random effect model as a significant heterogeneity ($I^2 > 80.0\%$) is observed with a $p < 0.001$ in the Q-test (Table 2). Forest plot revealed the overall prevalence rate of overweight and obesity was 25.0% and 13.1%, respectively (Fig 2). When stratified to gender, there is no difference in the prevalence of overweight between females (15.3%) compared to males (12.6%), but, interestingly, prevalence of obesity is higher in females (15.3%) compared to males (12.6%) (Figs 3, 4).

Publication bias

Funnel plot as well as Begg's and Egger's tests were employed to evaluate the possible existence of publication bias in the meta-analysis. The shape of the funnel plot showed a degree of asymmetry (plots not evenly distributed) (Fig 5). However, further statistical evidences from Begg's and Egger's tests revealed that the p-values in overall and all subgroup analyses were > 0.05, indicating the risk of publication bias is radically low and there is no systematic difference between studies of higher and lower precision. Therefore, no publication bias was present in the meta-analysis.

DISCUSSION

This meta-analysis is the first to report the prevalence of overweight and obesity in Malaysia based on independent observation studies published in PubMed database from 2010 to 2016. Overall, the prevalence rate of overweight in Malaysia is 5.0% lower than data reported in the National Health and Morbidity Survey 2015 (MIPH, 2015). The higher prevalence of obesity in females than males observed in the meta-analysis is contrary to the reported data in the National Health and Morbidity Survey of the same year: 28.3% in females and 31.6% in males (MIPH, 2015). The prevalence rates of obesity for all subgroups from the meta-analysis are

Table 1
Characteristics of literatures eligible for the meta-analysis.

Reference	Number of overweight subjects			Number of subjects with obesity		
	Overall	Male	Female	Overall	Male	Female
Boo *et al* (2010)	31	23	8	8	6	2
Cheong *et al* (2010)	105	46	59	59	23	36
Zaki *et al* (2010)	646	327	319	386	149	237
Mohamud *et al* (2011)	1,457	N/A	N/A	847	N/A	N/A
Chang *et al* (2012)	103	N/A	N/A	31	N/A	N/A
Gopalakrishnan *et al* (2012)	46	24	22	15	12	3
Hasnah *et al* (2012)	57	N/A	57	39	N/A	39
Hazizi *et al* (2012)	69	31	38	48	22	26
Ihabi *et al* (2013)	78	N/A	78	38	N/A	38
Chu and Moy (2014)	269	131	138	181	52	129
Fadzlina *et al* (2014)	162	N/A	N/A	96	N/A	N/A
Shariff *et al* (2014)	219	N/A	219	145	N/A	145
Hazmi *et al* (2015)	117	N/A	N/A	75	N/A	N/A
Wong *et al* (2015)	181	101	80	69	42	27
Ahmad *et al* (2016)	179	56	123	116	33	83
Al-Sadat *et al* (2016)	210	82	128	116	56	60
Fournier *et al* (2016)	440	N/A	N/A	190	N/A	N/A
Pell *et al* (2016)	1,019	506	513	690	267	423

N/A, data not available.

Table 2
Meta-analysis of prevalence rates of overweight and obesity in Malaysia, 2010-2016.

Subgroup	Prevalence rate (95% CI)	Number of studies	Heterogeneity		Model	Begg's test z; *p*	Egger's test t; *p*
			I^2 (%)	Q-test			
Overweight							
Overall	0.250 (0.210-0.296)	15[a]	97.7	<0.001	Random	0.049; 0.961	0.507; 0.621
Male	0.251 (0.194-0.318)	10	95.5	<0.001	Random	0.805; 0.421	0.084; 0.935
Female	0.252 (0.204-0.306)	13	95.4	<0.001	Random	0.732; 0.464	0.429; 0.676
Obese							
Overall	0.131 (0.107-0.161)	15[a]	96.6	<0.001	Random	0.841; 0.400	1.358; 0.198
Male	0.126 (0.102-0.154)	10	83.8	<0.001	Random	0.268; 0.789	0.059; 0.954
Female	0.153 (0.117-0.198)	13	95.0	<0.001	Random	1.220; 0.222	0.925; 0.375

[a]Excluding three studies reporting only females. CI, confidence interval.

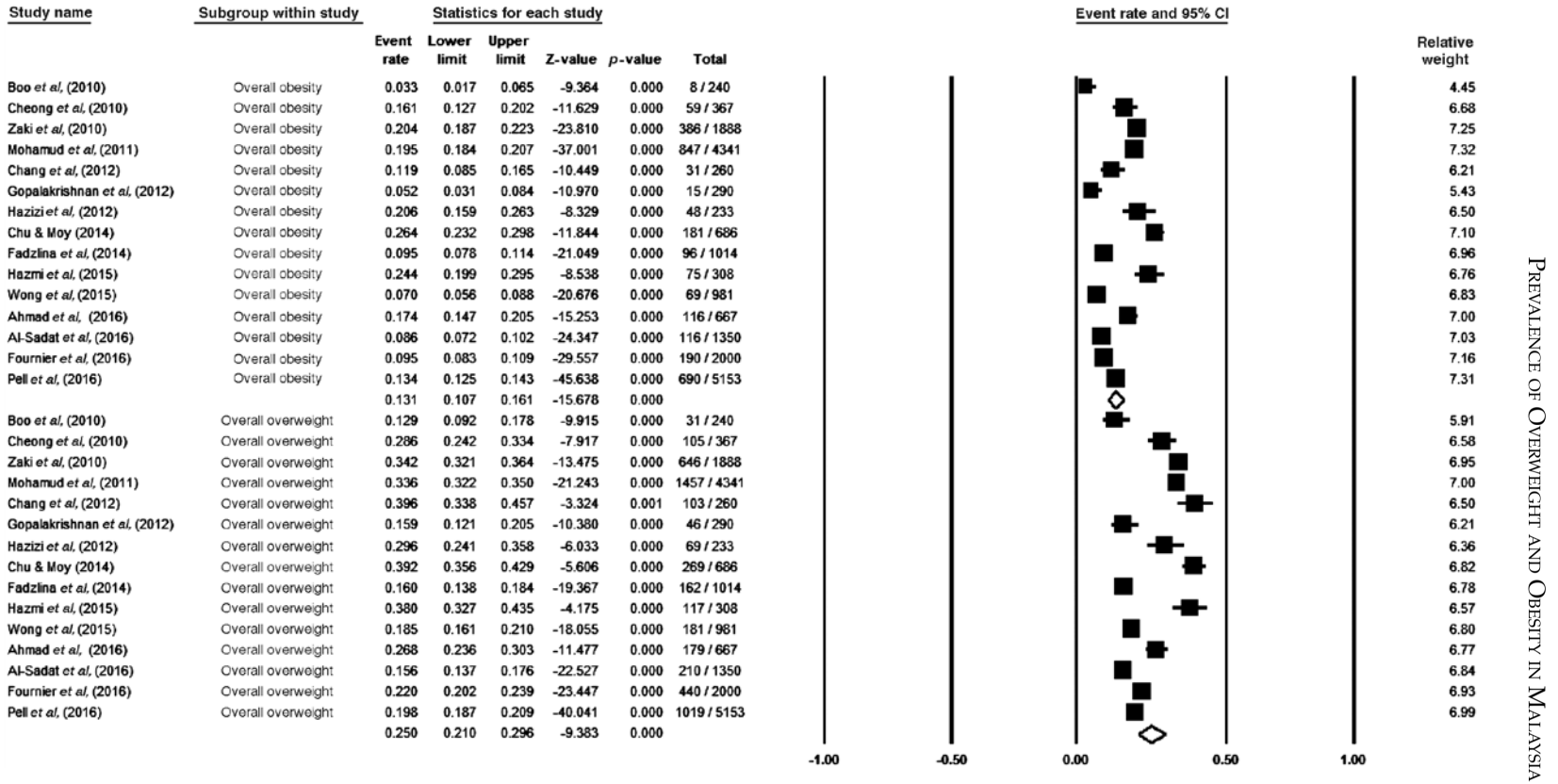

Fig 2-Forest plot of prevalence of overweight and obesity in Malaysia, 2010-2016. Three studies reporting only females were not included in the analysis. Black box represents the event rate and the horizontal line indicates the 95% confidence intervals of each study. Blank diamond represents the average event rate and the horizontal points of the diamond indicate the 95% confidence intervals of the combined studies.

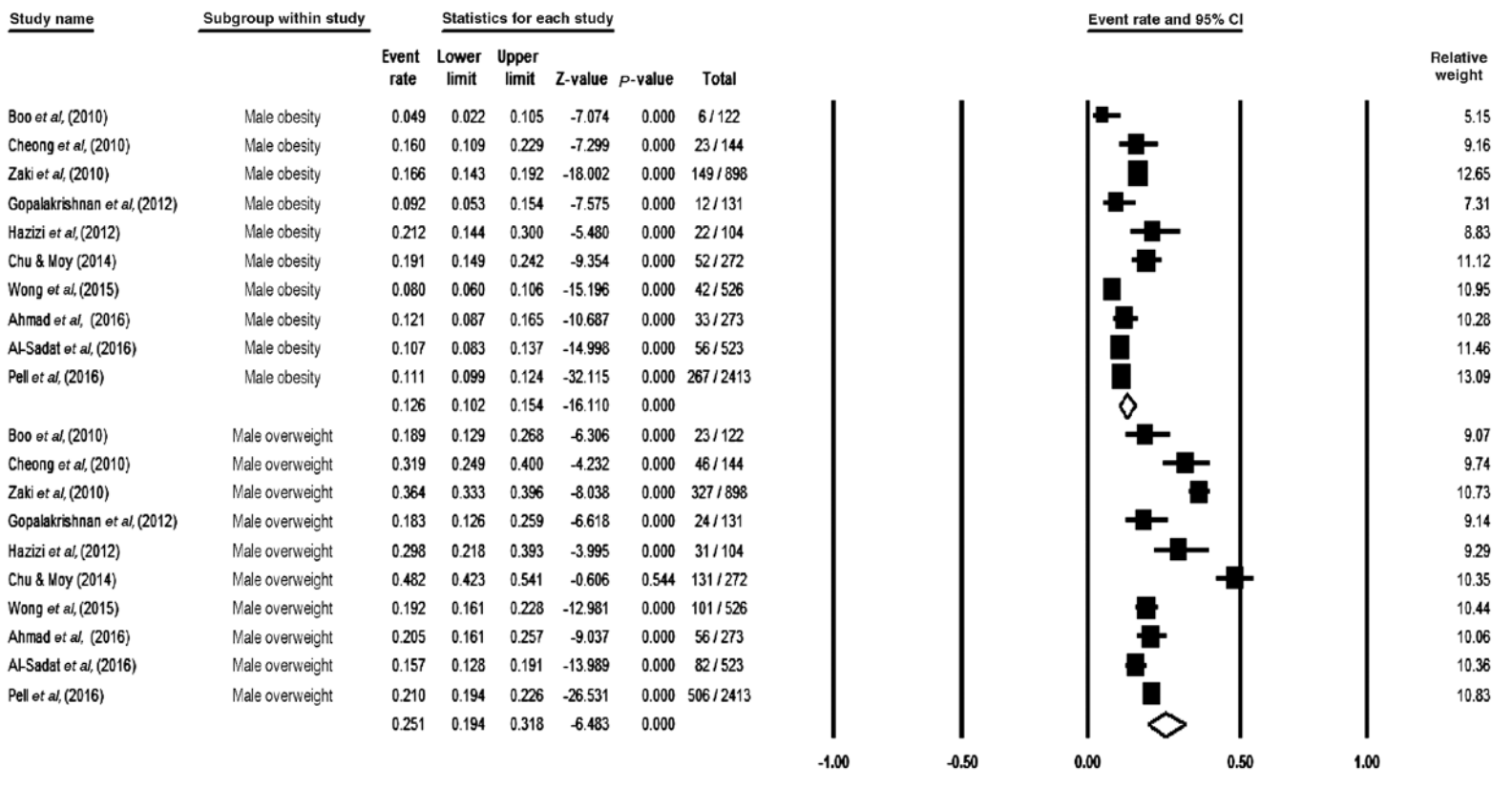

Fig 3-Forest plot of prevalence of overweight and obesity in Malaysian males, 2010-2016. Black box represents the event rate and the horizontal line indicates the 95% confidence intervals of each study. Blank diamond represents the average event rate and the horizontal points of the diamond indicate the 95% confidence intervals of the combined studies.

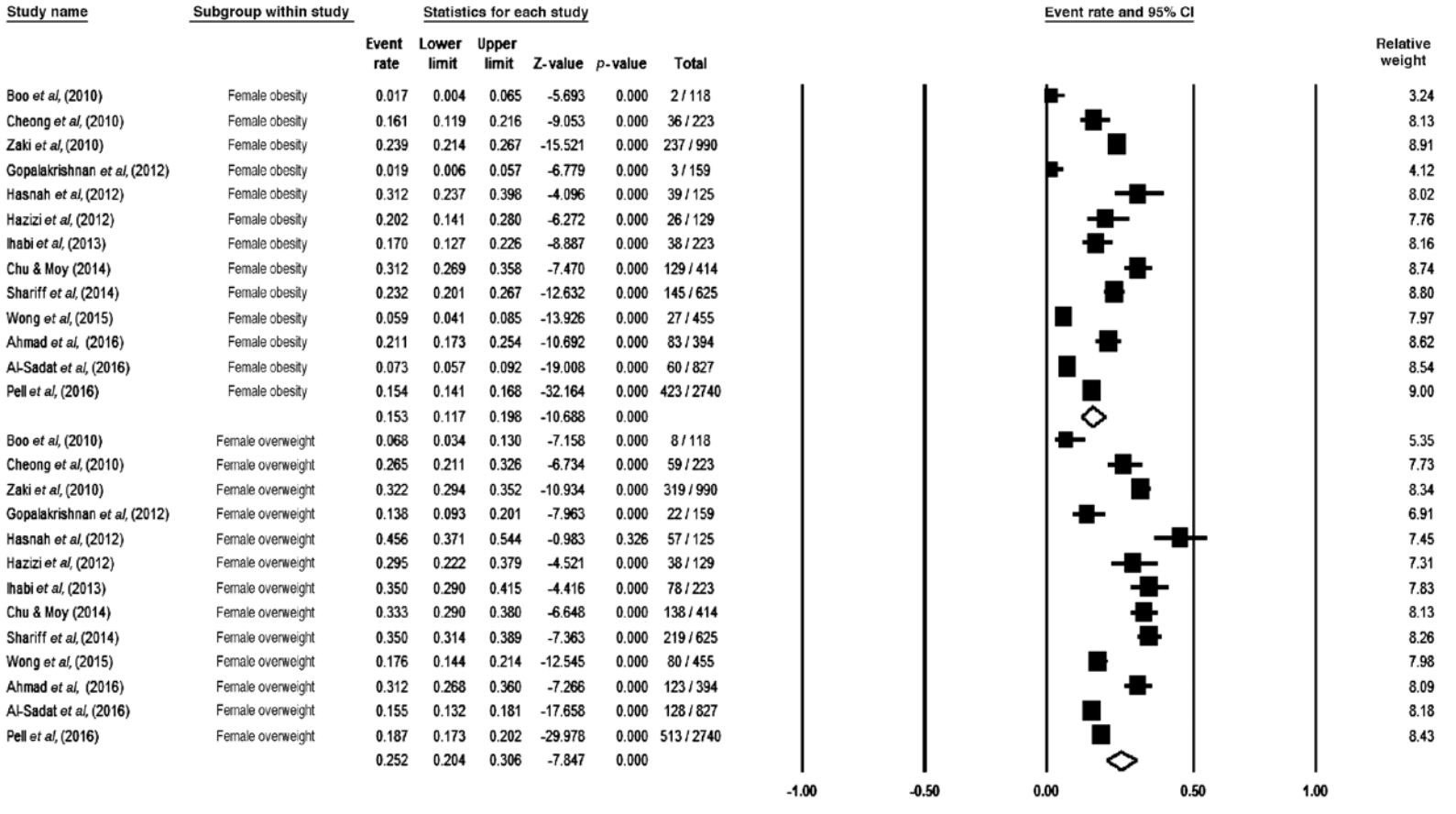

Fig 4-Forest plot of prevalence of overweight and obesity in Malaysian females, 2010-2016. Black box represents the event rate and the horizontal line indicates the 95% confidence intervals of each study. Blank diamond represents the average event rate and the horizontal points of the diamond indicate the 95% confidence intervals of the combined studies.

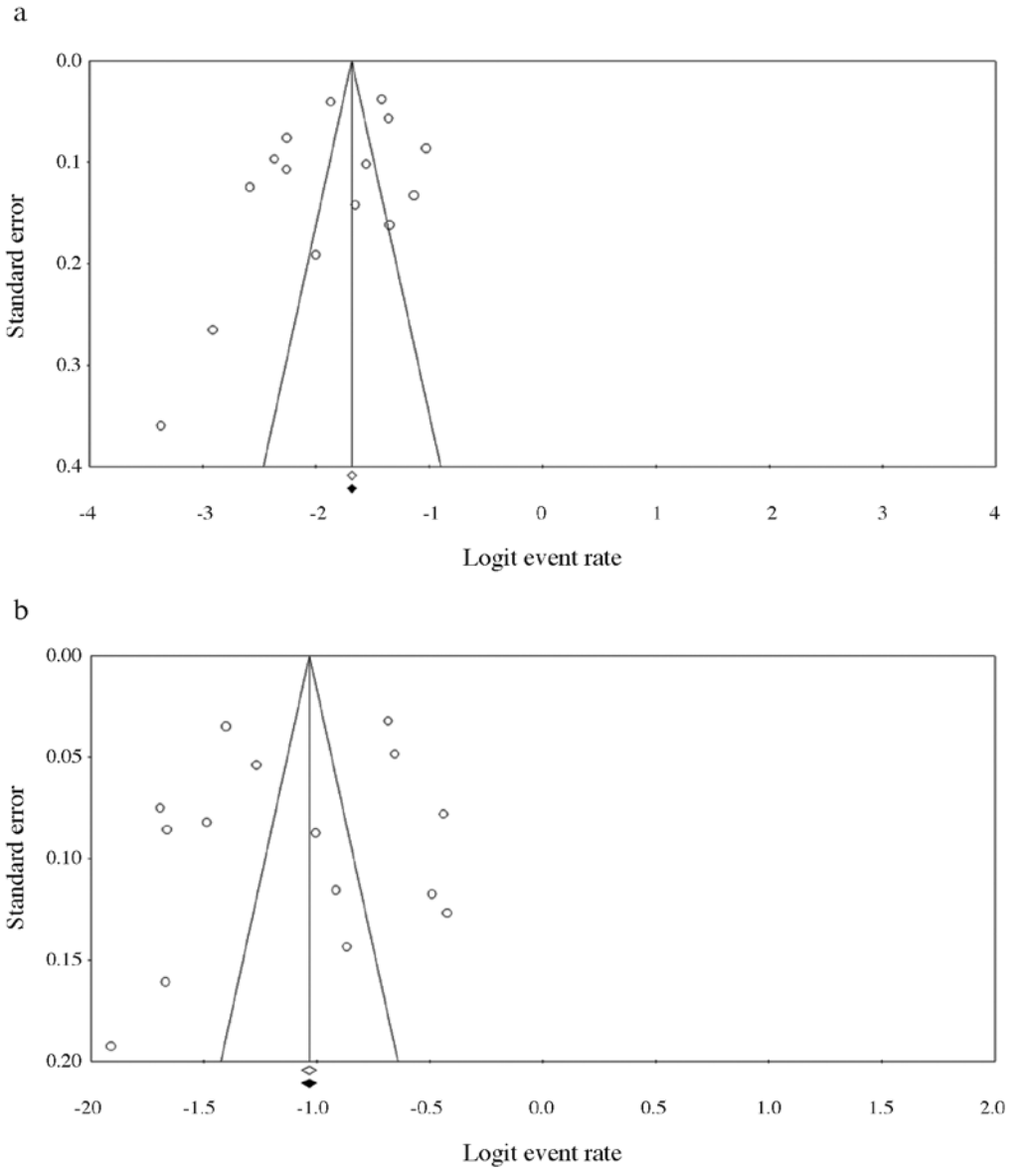

Fig 5-Funnel plots of standard error by logit event rate for (a) overall obesity and (b) overall overweight in Malaysia, 2010-2016.

lower than those estimated in the National Health and Morbidity Survey 2015.

Similar to the meta-analysis, a recent study reported the prevalence of overweight and obesity in females are higher than in males in most of the Southeast Asian countries except for Brunei, Singapore and Vietnam (Ng *et al*, 2014). The etiology of overweight and obesity remains indeterminate, but the prevalence of overweight and obesity seems to be gender-dependent. Obesity pandemic is

very different for males and females and thus, medical treatment for obesity should be gender-tailored (Burke *et al*, 2016). In addition to gender, genetic background and everyday life dietary and environmental factors are also commonly linked with obesity (Marti *et al*, 2004; Te Morenga *et al*, 2012; Sackner-Bernstein *et al*, 2015). Thus, more detailed investigations on these factors are needed to unravel the complex causal features of obesity if future prevention and management of obesity (and overweight) are to have any chance of success.

There are a number of limitations in this meta-analysis. Firstly, only independent observation studies from year 2010-2016 published in the PubMed database were included in this meta-analysis, and it is possible studies were published in other databases during the period of study, which if included, could alter the conclusions. Secondly, other subgroup analyses such as age, ethnicity, lifestyle and genetic inheritance of subjects that may influence the prevalence rate of overweight and obesity were not included due to data limitation.

In summary, this meta-analysis revealed the prevalence rate of overweight and obesity in Malaysia was 25.0% and 13.1%, respectively, and females had a higher prevalence rate of obesity compared to males. The meta-analysis may provide an additional comprehensive data for the relevant organizations involved in monitoring prevalence trends of overweight and obesity in Malaysia to utilize in their future management of overweight and obesity in the country.

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