Metabolic Syndrome among Indigenous People (*Orang Asli*) in Peninsular Malaysia: A Systematic Review

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Metabolic syndrome is a cluster of conditions that increase the risk of developing chronic diseases. This paper aims to assess the data on metabolic syndrome among indigenous *Orang Asli* in Malaysia. Searches were carried out using electronic databases of CINAHL, Medline, PubMed, and Scopus using predefined keywords. Cross-sectional studies of metabolic syndrome using any clinical diagnosis criteria among adult *Orang Asli* in Peninsular Malaysia included. Fifteen studies with these criteria were selected, five with metabolic syndrome studies. The general prevalence (weighted mean) of metabolic syndrome in *Orang Asli* was 26.3% (range: 12.0–39.8). Metabolic syndrome was more frequent in females (30.0%) than in males (19.3%). The most common components of metabolic syndrome were low HDL-C levels (41.0%) and hypertension (33.7%). For abdominal obesity, high triglycerides, and abnormal glycemia, the prevalence was; 24.6%, 21.5%, and 14.0%, respectively. Conclusively, the present systematic review brings us closer to an understanding of the prevalence of metabolic syndrome among this vulnerable population. The methodological differences among the studies published limit a joint analysis of their results. Nevertheless, finding from this review shows their high prevalence of the metabolic syndrome is comparable with other ethnic groups in Malaysia that requires immediate attention from all related parties.

Keywords: indigenous; *orang asli*; adult; Malaysia; metabolic syndrome; prevalence

I. INTRODUCTION

Metabolic syndrome is a cluster of risk factors that occur together, which increases the risk of developing heart diseases, stroke, and type 2 diabetes mellitus (Cornier *et al.*, 2008). The risk factors include increased blood pressure, high blood sugar, abdominal obesity, and abnormal triglyceride, or high-density lipoprotein cholesterol levels (Alberti *et al.*, 2005).

According to the findings of a systematic analysis for the Global Burden of Disease Study 2015 by Forouzanfar *et al.* (2016), a large body of epidemic studies has demonstrated that metabolic risks contribute significantly to preventable chronic NCDs morbidity and mortality. For analysis based on country, the major risk factors in terms of disability-adjusted life-years (DALYs) for both sexes combined in 2015 for Malaysia are; increased blood pressure, increased fasting plasma glucose, high body mass index and high total

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cholesterol. Increased prevalence of metabolic syndrome reflects the behavioural risk factor of an unbalanced diet and sedentary lifestyles in the populations (Institute for Public Health Malaysia, 2015; Lim and Cheah, 2016).

Malaysia is a multi-ethnic heterogeneous population consisting of major ethnic of Malays (51%), Chinese (27%), Indians (8%), and mixed ethnic groups, including indigenous groups (14%). In Peninsular (West) Malaysia, 0.5% of the population comprises of the minority indigenous people of *Orang Asli* (Department of Statistics Malaysia, 2000). There are large tribes and smaller subtribes that are categorised based on their physical characteristics, cultural practices, and linguistics. The three large tribes are the Negrito in the northern region, the Senoi in the central area, and the Proto-Malay in the southern part of Peninsular Malaysia (Endicott, 2015).

The Government of Malaysia has put up continuous effort to bring modernisation to the *Orang Asli* through the Department of *Orang Asli* Development (JAKOA) of Malaysia. This modernisation has shifted the epidemiological trend of diseases among the *Orang Asli*, particularly the *Orang Asli*, at the peripheries of townships. They have adopted modern life with a more sedentary lifestyle and a change in diet. Even though the studies among this population is limited, previous surveys of metabolic syndrome focused on specific groups of *Orang Asli* shows that their prevalence is comparable with Malaysian general populations (Aziz *et al.*, 2015; Aghakhanian *et al.*, 2018).

The *Orang Asli* was reported to have a low health status, low socioeconomic status, and they are lagging in terms of education (Masron *et al.*, 2013). Increased prevalence of metabolic syndrome marks high utilisation and costs of medical care not only to the individuals who are affected but also to their family and the government (Boudreau *et al.*, 2009). Hypothetically, continuous adaptation to an urbanised lifestyle leads to an increased burden of metabolic syndrome among the *Orang Asli*. Analysing available data on these minorities is essential to provide a snapshot of their state of health. This data will give a real prevalence of this syndrome among the *Orang Asli* population.

Therefore, the objective of the present systematic review is to assess the prevalence of metabolic syndrome and its criteria in the *Orang Asli* using data published in scientific works of literature.

II. METHODS

A. Source and Search Strategy

Searches were conducted using electronic databases of CINAHL, Medline, PubMed and Scopus. These electronic databases were assessed until 12 September 2019. Additional studies also identified by retrieval from the reference list of selected articles.

B. Keyword Search

These terms were searched in full text:

- [metabolic syndrome OR syndrome X OR metabolic syndrome X];
- [*Orang Asli* OR indigenous OR native OR aboriginal OR original OR proto-Malay OR Senoi OR negrito]; and
- Malaysia

C. Selection of Research Article/ Inclusion and Exclusion Criteria

Eligible studies: 1) were observational studies; 2) stratified participants based on the presence or absence of the metabolic syndrome criteria using any metabolic syndrome definitions; 3) were conducted among any *Orang Asli* population; 4) reported outcomes as count data, or prevalence and 5) were published in the English and Malay language.

Studies investigating more than one metabolic syndrome, or more than one definition of the metabolic syndrome were also eligible for inclusion. Studies not meeting these criteria were excluded.

Criteria for in- or excluding retrieved articles formulated based on the discussion of the research team members. The criteria tested on two batches at the title and abstract and also the full-text level of twenty articles regarding their relevance, as well as understandability and practicality to eliminate the bias in study selection.

Two reviewers (MI and NME) independently screened each title and abstract, which categorised as include, exclude, or

unsure. The titles and abstracts were compared and then categorised again following a consensus discussion if the two reviewers disagreed. When there was an agreement to exclude, the citation excluded at this stage. Articles with an agreement to include or as unsure were reviewed by reading the full text. Studies considered as unsure after reading the full text reviewed by a third reviewer (KNNA). Reasons for exclusion documented at the full-text stage of the screening process.

D. Data Extraction and Management

Two reviewers independently extracted data using standardised data extraction forms. Disagreements were resolved by consensus or, when necessary, by a third reviewer. Reviewers extracted information on author and year of publication, year of conducted study, number and gender of participants, the age range of the population, sampling, tribe of the *Orang Asli*, the city in which the study was carried out and procedures to determine metabolic syndrome and its components (measurements) as well as the prevalence of metabolic syndrome and its components.

The (weighted) mean prevalence rates found in the present review were calculated as follows: the sum of the number of cases in all studies considered/sum of the number of participants in all studies considered x 100.

III.   RESULT

As shown in the flow diagram (Figure 1), 160 articles were initially identified using the keywords. Ten additional records found through other sources. After duplicate records removed, 167 records were screened based on inclusion and exclusion criteria. Fifteen articles were finally chosen to be reviewed and summarised in Table 1.

A. Prevalence of Metabolic Syndrome

The five studies included in this section encompassed 1196 *Orang Asli* published from 2016 to 2019 (Table 1). In these five studies, the general prevalence of metabolic syndrome (Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018; Mokhsin *et al.*, 2018; Zahary *et al.*, 2019) was reported. In these studies that mentioned rates of prevalence, the

weighted mean for metabolic syndrome general prevalence was 26.3%.

Three studies (Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018) used Joint Interim Statement's (Alberti *et al.*, 2009) definition as a measure of metabolic syndrome, whereas Mokhsin *et al.* (2018) used International Diabetes Federation's (Alberti *et al.*, 2006) definition. Another recent study by Zahary *et al.* (2019) used a modified National Cholesterol Education Program High Blood Cholesterol ATP III metabolic syndrome criterion.
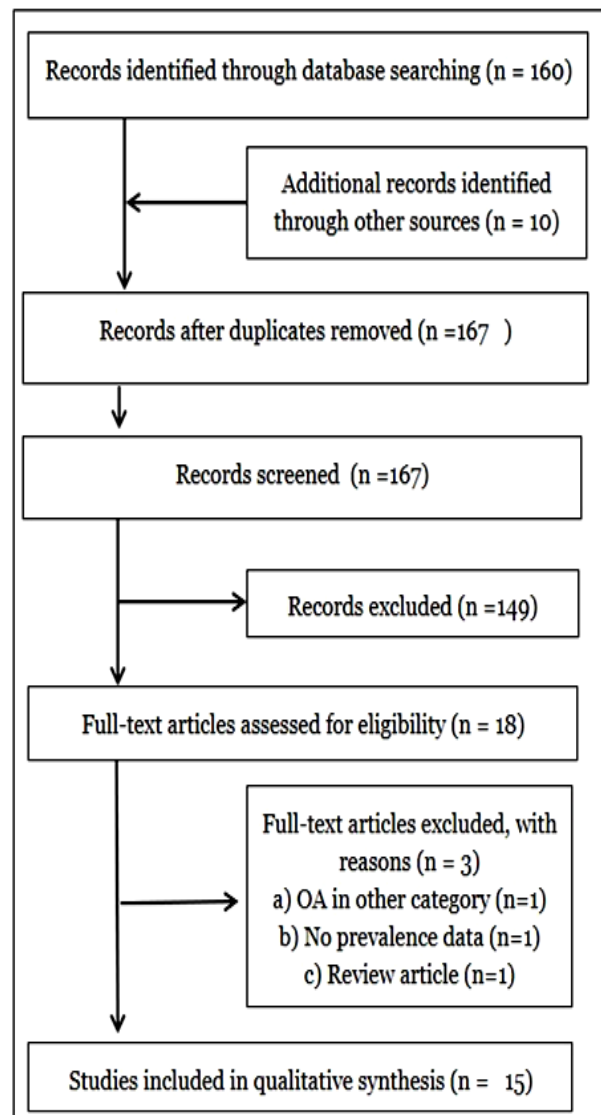

Figure 1. Flow diagram of selection of studies (Moher *et al.*, 2009)

Studies among the Senoi tribe showed that the prevalence of metabolic syndrome was 25.2% (Ali *et al.*, 2016) and 39.8% (Zahary *et al.*, 2019). One study among Negrito by Mokhsin *et al.* (2018) had the prevalence of metabolic syndrome at

12.0%. Two studies, among all the *Orang Asli* tribe, reported a prevalence rate of 17.0% (Ashari *et al.*, 2016) and 29.6% (Aghakhanian *et al.*, 2018). They also reported that the prevalence of female with metabolic syndrome was significantly higher compared to male counterparts (Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018) with the weighted mean for gender-adjusted prevalence was 30.0% and 19.3% respectively (Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018; Mokhsin *et al.*, 2018; Zahary *et al.*, 2019).

B. Prevalence of the Components of Metabolic Syndrome

The prevalence of the cluster of risk factors for metabolic syndrome among the populations varied from one ethnic group to another as well as the measure definition (Table 1).

Abdominal obesity: The prevalence of abdominal obesity (AO) reported in twelve studies. Two studies used waist circumference cut-point values of 102cm for males and 88cm for females (Yusof *et al.*, 2007; Azuwani *et al.*, 2013). The other ten studies used cut-point values of 90cm for males and 80cm for females (Haemamalar *et al.*, 2010; Mohamud and Suraiami, 2010; Phipps *et al.*, 2015; Ali *et al.*, 2016; Ashari *et al.*, 2016; Chua *et al.*, 2017; Aghakhanian *et al.*, 2018; Ahmad *et al.*, 2018, Mokhsin *et al.*, 2018; Wong *et al.*, 2018; Zahary *et al.*, 2019). Reported prevalence range from 0.8% to 37.0%. The weighted mean prevalence was 24.6%.

Abnormal glycemia: Nine studies mentioned the prevalence of abnormal glycaemia (AG) among the *Orang Asli* population (Mohamud and Suraiami, 2010; Phipps *et al.*, 2015; Ali *et al.*, 2016; Ashari *et al.*, 2016; Aziz *et al.*, 2016; Aghakhanian *et al.*, 2018; Ahmad *et al.*, 2018, Mokhsin *et al.*, 2018; Wong *et al.*, 2018). In these nine studies, the weighted mean prevalence of AG was 14.0%, with the reported prevalence ranging from 1.5% to 34.8%.

Hypertension: The weighted mean prevalence of high blood pressure or hypertension (HPT) was found to be 33.7% in the nine studies that reported on the general prevalence of this component ranging from 21.8% - 73.6% (Jinam *et al.*, 2008; Azuwani *et al.*, 2013; Phipps *et al.*, 2015; Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018; Ahmad *et al.*, 2018; Mokhsin *et al.*, 2018; Wong *et al.*, 2018). In four, the cut-point value for systolic blood pressure was 130 mmHg or more and diastolic blood pressure of 85 mmHg or more (Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018; Ahmad *et al.*, 2018). Whereas, four studies used a cut-point value of 140 mmHg or more and diastolic blood pressure of 90 mmHg or more (Jinam *et al.*, 2008; Phipps *et al.*, 2015; Mokhsin *et al.*, 2018; Wong *et al.*, 2018). One study did not specify the cut-point values used to categorise HPT (Azuwani *et al.*, 2013).

Dyslipidemia: High triglyceride (TG) and low HDL cholesterol (HDL-C) is the characteristics of dyslipidaemia seen in six studies (Phipps *et al.*, 2015; Ali *et al.*, 2016; Ashari *et al.*, 2016; Aziz *et al.*, 2016; Aghakhanian *et al.*, 2018; Ahmad *et al.*, 2018). Another two studies looked at the components of high TG (Wong *et al.*, 2018) and low HDL-C (Mohamud and Suraiami, 2010). The weighted mean of high TG was 21.5%, and for low levels of HDL cholesterol, the weighted mean was 41.0%.

IV.   DISCUSSION

This review provides an overall picture of the presence of metabolic syndrome among the *Orang Asli* population in Malaysia. According to data reviewed, the weighted mean prevalence of metabolic syndrome in the *Orang Asli* (26.3%) is as high as the reported study by Rampal *et al.* in 2012 among the Malaysian population. Ethnic disparities in metabolic syndromes in Malaysia was 35.6% among Indians, 30.5% among indigenous Sarawakians, 26.4% among Malays and 26.2% among Chinese (Rampal *et al.*, 2012). With the pattern like other ethnicities in Malaysia, there is no doubt that metabolic syndrome is going to be a more challenging public health issue to tackle among the *Orang Asli*.

This review found that the overall prevalence of metabolic syndrome was higher among Senoi as compared to Negrito. However, in research by Aghakhanian *et al.* in 2018, metabolic syndrome prevalence was the highest among the Proto-Malays, followed by Negritos and Senois. There was a wide variation in the prevalence of metabolic syndrome amongst different *Orang Asli* groups, with the highest metabolic syndrome and non-communicable diseases prevalence was observed, particularly among the *Orang Asli*

who inhabited urbanised fringe areas (Jinam *et al.*, 2008; Aziz *et al.*, 2016). Risk factors for metabolic syndrome include an unhealthy diet and a sedentary lifestyle. Their adaptation greatly influenced *Orang Asli*'s lifestyle to the environment as their source of food. For the *Orang Asli*, who mainly live in the fringe, the transition to modernisation leads to a modification in their lifestyle behaviour. Poor diet and physical inactivity were the behavioural risk factors for metabolic syndrome that are preventable (Ashari *et al.*, 2016; Forouzanfar *et al.*, 2016). Physical inactivity prevalence among *Orang Asli* was as high as the general Malaysian population (Institute for Public Health Malaysia, 2015; Pell *et al.*, 2016; Wong *et al.*, 2018). In a study by Rohin *et al.* in 2018, 27.6% of *Orang Asli* exceed the daily recommended intake of carbohydrate, 19.0 % of daily protein, and 16.0% of daily fat.

In our review, the mean prevalence of female with metabolic syndrome was higher than male gender, and this differs from studies by Ashari *et al.* in 2016 and Aghakhanian *et al.* in 2018. These gender differences are not consistent across the tribe category and geographic locations. However, the finding of a higher prevalence of metabolic syndrome in females in our study was comparable with studies in the general Malaysian population (Mohamud *et al.*, 2011; Rampal *et al.*, 2012). In our results, the most common component of metabolic syndrome was low HDL cholesterol (41.0%). In studies comparing the prevalence of HDL-C among rural Malay and *Orang Asli* (Ali *et al.*, 2016; Ahmad *et al.*, 2018), no significant difference found, which suggests the need for monitoring during medical screening among this communities.

The mean prevalence of high blood pressure among the *Orang Asli* in this review is higher compared to the national survey by the Institute for Public Health Malaysia in 2015. However, abdominal obesity and abnormal glycemia were lower in this review. These groups of *Orang Asli* often included other groups of ethnicity categories in government health surveys or researches among the Malaysian population. Therefore, the number may not represent their actual health conditions. Reported data on *Orang Asli* shall be analysed in their category, so targeted intervention can be conducted among these minorities (Mohamud *et al.*, 2011; Institute for Public Health Malaysia; 2015).

Another limitation that makes comparability among studies difficult is the different methods used. For the clinical diagnosis of metabolic syndrome, the cluster of risk factors was the same for any definition used. However, the measurement used for cut-point values may vary across studies depending on the definition used by the author (Alberti *et al.*, 2009). To diagnose metabolic syndrome, the majority (three) of studies used the JIS 2009 criteria (Ali *et al.*, 2016; Ashari *et al.*, 2016; Aghakhanian *et al.*, 2018); one was based on the IDF 2006 criteria (Mokhsin *et al.*, 2018) and one was based on modified NCEP-ATP III (Zahary *et al.*, 2019) (Table 1).

The trend of diseases in the *Orang Asli* have changed recently from communicable to non-communicable diseases because of the shifts in nutrition and lifestyle habits among the population. Adaptation to modern life has transformed dietary intake, social and lifestyle behaviours, leading to a reduction in their health status not only in Malaysia but also among indigenous people worldwide (Burns and Thomson, 2006; Haemamalar *et al.*, 2008; Jinam *et al.*, 2008).

Due to the high burden of the chronic diseases' management and healthcare cost, studies to describe modifiable environmental and behavioural factors associated with the development of metabolic syndrome is essential. This information is beneficial, especially for potentially modifiable factors such as nutrition and physical inactivity (Forouzanfar *et al.*, 2016; Wong *et al.*, 2018). Since the *Orang Asli* population is heterogeneous, the information specifying the people who have a higher risk of developing metabolic syndrome should be conducted. This information allows a targeted program and intervention that suit the need of the population. Another critical aspect of metabolic syndrome prevention is their knowledge of diseases (Nor Afiah *et al.*, 2017; Ithnin *et al.*, 2018). Previous studies among *Orang Asli* reported a low level of knowledge on diseases and their prevention (Al-Adhroey *et al.*, 2010; Ahmad *et al.*, 2013; Nasr *et al.*, 2013). It is, therefore, essential to increase knowledge about metabolic syndrome and its causes, as such knowledge could reduce the prevalence of metabolic syndrome.

V. CONCLUSION

To the best of our knowledge, this is the first systematic review on the prevalence of metabolic syndrome and its components among indigenous *Orang Asli* populations in Malaysia. Studies among them are limited but starting to increase over the years. The prevalence of metabolic syndrome was as high as the general Malaysian population. Our data also suggest the need for multi-centre studies using current criteria and standardised methods for each ethnic group to make it possible to determine the precise scope of this problem among the *Orang Asli* populations. Knowledge of diseases may be helpful in the monitoring of metabolic syndrome and could contribute to planning and prevention strategies to combat this condition. High risk of morbidity and mortality of these conditions also increase healthcare costs for the populations and Malaysia government. Hence, all efforts to involve all relevant parties of researchers, communities and government are crucial for disease prevention among these vulnerable populations.

VI. CONFLICT OF INTEREST

The authors declare that they have no competing interests.

VII. ACKNOWLEDGEMENTS

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Table 1. Cross-sectional studies of the prevalence of metabolic syndrome among *Orang Asli* populations included in the present review

Author	Study period	Population study	City, State	Cut-Points value	Metabolic syndrome definition	Overall prevalence MetS(%)	Prevalence of individual components of MetS (%)	Associations*
Yusof *et al.*, 2007	2002	138 adults, ≥16 years old M and F 58.7% Negrito, 41.3% Senoi	Lembah Belum, Perak	AO: WC; M >102 cm, F >88cm High G: - High TG: - Low HDL-C: - HPT: -	-	-	AO: 0.8 High G:- High TG: - Low HDL-C: - HPT: -	-
Jinam, *et al.*, 2008	-	129 adults, ≥20 years old M and F 38.4% Proto-Malay, 61.6% Negrito	Kuala Pilah and Jelebu, Negeri Sembilan, Grik, Perak Baling, Kedah	AO: - High G: - High TG: - Low HDL-C: - HPT: ≥140/90 mmHg	-	-	AO: - High G:- High TG: - Low HDL-C: - HPT: 49.6	-
Haemamalar *et al.*, 2010	-	57 adults, ≥18 years old M and F 100% Senoi	Krau Wildlife Reserve, Pahang	AO: WC; M >90 cm, F >80cm High G: - High TG: - Low HDL-C: - HPT: -	-	-	AO: 10.5 High G:- High TG: - Low HDL-C: - HPT: -	-
Mohamud & Suraiami, 2010	-	119 adults, ≥18 years old F only 100% Proto-Malay	Hulu Selangor, Selangor	AO: WC; F >80cm High G: FBG ≥5.6mmol/L High TG: ≥1.7mmol/L Low HDL-C: ≤1.29mmol/L HPT: -	-	-	AO: 19.6 High G: 34.8 High TG: 9.8 Low HDL-C: 44.6 HPT: -	-
Azuwani *et al.*, 2013	-	138 adults, ≥18 years old M and F 100% Senoi	Cameroon Highland, Perak	AO: WC; M >102 cm, F >88cm High G: - High TG: - Low HDL-C: - HPT: N/S	-	-	AO: 13.0 High G: - High TG: - Low HDL-C: - HPT: 42.0	-
Phipps *et al.*, 2015	-	636 adults, ≥18 years old M and F 50.8% Proto-Malay, 18.2% Senoi, 31.0% Negrito	Pekan, Pahang; Johor Bahru, Johor; Cameron Highlands, Perak; Kuala Langat, Selangor; Hulu Perak, Perak; Gua Musang, Kelantan	AO: WC; M >90 cm, F>80cm High G: FBG ≥6.1mmol/L High TG: ≥1.7mmol/L Low HDL-C: ≤M <1.0mmol/L, F <1.3mmol/L HPT: ≥140/90 mmHg	-	-	AO: 34.8 High G: 7.4 High TG: 23.9 Low HDL-C: 45.8 HPT: 29.6	-
Ali *et al.*, 2016	-	135 adults, ≥18 years old M and F 100% Senoi	Batang Padang and Hulu Perak, Perak	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L or on treatment	JIS, 2009	25.2	AO: 37.0 High G: 4.4 High TG: 22.2 Low HDL-C: 86.7	-

Study	Year	Sample	Location	Criteria	Definition	Prevalence	Components	Findings
				High TG: ≥1.7mmol/L or on treatment Low HDL-C: ≤M <1.03mmol/L, F <1.29mmol/L or on treatment HPT: ≥130/85 mmHg			HPT: 34.8	
Ashari *et al.*, 2016	2011-2013	159 adults, ≥18 years old M and F 6.9% Proto-Malay, 43.4% Senoi, 49.7% Negrito	Kota tinggi, Johor; Kuala Lipis and Lanchang, Perak; Baling, Kedah; Lanchang, Perak	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L High TG: ≥1.7mmol/L Low HDL-C: <1.0mmol/L HPT: ≥130/85 mmHg	JIS, 2009	17.0	AO: 37.0 High G: 4.4 High TG: 22.2 Low HDL-C: 86.7 HPT: 34.8	Chi-square test: Females had a significantly higher prevalence of MetS , (23.8 vs. 5.2 %, P = 0.002)
Aziz *et al.*, 2016	-	85 adults, ≥18 years old M and F 5.8% Proto-Malay, 37.2% Senoi, 57.1% Negrito	Pahang, Kelantan, Perak, Kedah, Johor	AO: WC; - High G: FBG ≥6.1mmol/L High TG: ≥1.7mmol/L Low HDL-C: <1.0mmol/L HPT: -	-	-	AO: - High G: 24.7 High TG: 20.0 Low HDL-C: 34.1 HPT: 25.9	-
Chua *et al.*, 2017	-	482 adults, ≥18 years old M and F 27.4% Proto-Malay, 72.6% Senoi	Krau Wildlife Reserve, Pahang	AO: M >90 cm, F >80cm High G: - High TG: - Low HDL-C: - HPT: -	-	-	AO: 22.4 High G: - High TG: - Low HDL-C: - HPT: -	-
Aghakhanian *et al.*, 2018	2010-2016	629 adults, ≥18 years old M and F 50.1% Proto-Malay, 23.7% Senoi, 26.3% Negrito	Pahang, Johor Selangor, Perak Perak, Kelantan	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L or on treatment High TG: ≥1.7mmol/L Low HDL-C: M <1.0mmol/L, F <1.3mmol/L HPT: ≥130/85 mmHg or on treatment	JIS, 2009	29.6	AO: 21.5 High G: 20.0 High TG: 19.1 Low HDL-C: 17.6 HPT: 21.8	Chi-square test: Females had a significantly higher prevalence of MetS, (35.25% vs 21.95%, P < 0.001) compared to males.
Ahmad *et al.*, 2018	2013	133 adults, ≥18 years old M and F 100% Senoi	Batang Padang and Hulu Perak, Perak	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L or on treatment High TG: ≥1.7mmol/L Low HDL-C:M <1.0mmol/L, F <1.3mmol/L or on treatment HPT: ≥130/85 mmHg	-	-	AO: 26.9 High G: 3.8 High TG: 33.7 Low HDL-C: 62.5 HPT: 39.4	-
Mokhsin *et al.*, 2018	-	150 adults, ≥18 years old M and F 100% Negrito	Gua Musang, Kelantan	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L High TG: ≥1.7mmol/L or on treatment	IDF, 2006	12.0	AO: 14.0 High G: 1.5 High TG: - Low HDL-C: - HPT: 57.2	-

				Low HDL-C:M <1.0mmol/L, F <1.3mmol/L or on treatment HPT: ≥130/85 mmHg				
Wong *et al.*, (2018)	2015	72 adults, ≥18 years old M and F 100% Proto-Malay	Tasik Chini, Pahang	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L L, RBG≥11.1mmol/L or on treatment High TG: ≥1.7mmol/L Low HDL-C: - HPT: ≥140/90 mmHg	-	-	AO: 33.3 High G: 25.0 High TG: 6.9 Low HDL-C: - HPT: 73.6	-
Zahary *et al.*, 2019	-	123 adults, ≥18 years old M and F 100% Senoi	Gua Musang, Kelantan	AO: WC; M >90 cm, F>80cm High G: FBG ≥5.6 mmol/L or on treatment High TG: ≥1.7mmol/L or on treatment Low HDL-C: ≤M <1.03mmol/L, F <1.29mmol/L or on treatment HPT: ≥130/85 mmHg	modified NCEP-ATP III, 2006	39.8	AO: - High G: - High TG: - Low HDL-C: - HPT: -	-

MetS, metabolic syndrome; F, female; M, male; WC, waist circumference; G, glucose; AO, abdominal obesity; high G, hyperglycaemia; FBG, Fasting Blood Glucose; TG, triglyceride; HDL-C, High density lipoprotein-cholesterol; HPT, hypertension; JIS, Joint Interim Statement; IDF, International Diabetes Federation; NCEP-ATP III, National Cholesterol Education Program High Blood Cholesterol ATP III
*Only statistically significant associations are shown ($P<0.05$).