Prevalence of Metabolic Syndrome among Breast Cancer Survivors in East Coast of Peninsular Malaysia

Syed Amirfaiz
Universiti Sultan Zainal Abidin

Mohd Razif Shahril
Universiti Sultan Zainal Abidin

Pei Lin Lua
Universiti Sultan Zainal Abidin

Ali Nurnazahiah
Universiti Sultan Zainal Abidin

Nor Syamimi Zakarai
Universiti Sultan Zainal Abidin

Ving Lok
Universiti Sultan Zainal Abidin

Aryati Ahmad
Universiti Sultan Zainal Abidin

Suhaina Sulaiman
Universiti Kebangsaan Malaysia

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Abstract

To date, limited data are available on metabolic syndrome (MetS) prevalence among breast cancer survivors in Malaysia. Therefore, this study was conducted to determine the prevalence of MetS and abnormal MetS components among breast cancer survivors in East Coast of Peninsular Malaysia. This cross-sectional study included 95 breast cancer survivors (age 53.7±7.6 years) who have completed main cancer treatments for ≥6 months. Cancer survivors were recruited from two main government hospitals in Kelantan and Terengganu using a purposive sampling method. According to the Harmonized criteria, the MetS prevalence was 50.5%. Among those with MetS, the most prevalent abnormal metabolic components were triglycerides (91.2%), fasting blood glucose (79.6%) and HDL-c level (78.4%). Except for total cholesterol and LDL-c, all other MetS components were significantly different ($p<0.05$) between those with and without MetS. Significant differences between MetS and non-MetS groups were found for weight, BMI, waist circumference, body fat percentage and cancer stages ($p<0.05$). Otherwise, no significant difference was reported in other sociodemographic and clinical parameters between cancer survivors with and without MetS. In conclusion, MetS was highly prevalent among breast cancer survivors in this study, with weight, BMI, waist circumference, body fat percentage and cancer stages significantly affect MetS status.

Introduction

The growing number of data have shown that metabolic syndrome (MetS) and its independent components are related with plethora of cancers, including a higher risk of having breast cancer (Esposito et al. 2012; Uzunlulu, Telci Caklili, and Oguz 2016; Park et al. 2017). Similarly, breast cancer survivors were also reported to be susceptible to MetS (Bhandari et al. 2014; Bao et al. 2013). However, the number of studies conducted to assess MetS and MetS prevalence among breast cancer survivors in Malaysia is very scarce, with only one study known to have recently reported the prevalence of MetS among breast cancer patients in Malaysia. In this study conducted among 370 newly diagnosed breast cancer patients recruited from University Malaya Medical Centre (UMMC), the prevalence of MetS was reported to be 37.8%, using the modified IDF 2005 definition (Kiew et al. 2018). In comparison to MetS prevalence among breast cancer survivors in other Asian countries, the prevalence of MetS in India were reported to range between 32.1% (Kate and Kadambari 2016) and 40.0% (Wani et al. 2017), whereas MetS prevalence in China and Korea were 32.6% (Wu et al. 2018) and 43.9% (Lee et al. 2013) respectively. Meanwhile, studies conducted in the USA, Denmark and Brazil reported Mets prevalence among breast cancer survivors to be 26.1% (Calip et al. 2014), 15.1% (Fredslund et al. 2019), and 48.1% (Nahas et al. 2012) respectively.

In contrast, there are a lot more studies conducted on MetS prevalence among the general population. In Malaysia, the prevalence of MetS has been extensively reported (Lim and Cheah 2016). To summarize, MetS prevalence among general Malaysian women in three nationwide studies were reported to range between 30.1–43.7%% (Tan, Dunn, and Yen 2011; Mohamud et al. 2011; Rampal et al. 2012). Higher risk MetS was also reported to be linked with higher age, being obese, Indian ethnicity, lower education level,

unemployment and shift workers (Lim and Cheah 2016). Meanwhile, MetS prevalence have also been reported among general women population in other Asian and Western countries such as India (43.2%) (Ravikiran et al. 2010), China (34.2%) (Zuo et al. 2009), Thailand (36.4%) (Aekplakorn et al. 2011), Korea (11.4%) (Choi et al. 2015), Spain (30.7%) (Fernández-Bergés et al. 2012), Norway (34.2%) (Zisko et al. 2017) and Netherland (44.0%) (Zając-Gawlak et al. 2017).

Due to the inter-relationship between MetS and breast cancer, the study on MetS among breast cancer survivors could be a two-pronged investigation to counter these health issues at the same time. Nevertheless, up until today, limited data on the prevalence of MetS among breast cancer survivors in Malaysia have been published, especially in the East Coast of Peninsular Malaysia. Therefore, this study was conducted to determine the prevalence of MetS and abnormal MetS components among breast cancer survivors in East Coast of Peninsular Malaysia.

Methods

Study design and participants

In this cross-sectional study, breast cancer survivors were recruited by using purposive sampling method from the Surgical Outpatient Department (SOPD) of two main government hospitals in East Coast of Peninsular Malaysia; Hospital Sultanah Nur Zahirah (HSNZ) in Terengganu and Hospital Raja Perempuan Zainab II (HRPZ II) in Kelantan. The inclusion criteria for breast cancer survivors' recruitment in this study were; a) Malaysian women; b) adults (≥ 18 years old); c) have completed the active cancer treatments (surgery, chemotherapy or radiotherapy); d) completed at least four rounds of chemotherapy; e) at least six months of post-active treatments, and f) able to read and communicate in English or Malay. Breast cancer survivors were excluded if they had secondary, recurrent or stage four breast cancer, were pregnant, or if they had cardiovascular, orthopedic or medical conditions which could be worsened by exercise. Ethical approval was obtained from the Ministry of Health, Malaysia [(NMRR-14-1618-23717 (IRR)]. All potential research participants were briefed on the procedure, risks and benefits of the study. They were also informed that they could decide to drop out at any time of the study. Before data collection could be commenced, verbal and written consent from the breast cancer survivors were obtained.

Recruitment of breast cancer survivors

After obtaining ethical approval from the Ministry of Health and the administration of both hospitals, the name list of breast cancer survivors was obtained together with their contact numbers from the SOPD. All breast cancer survivors were personally contacted to briefly explain the research and queried for inclusion and exclusion criteria. At the same time, all eligible breast cancer survivors were invited to join the study. Those who gave verbal consent were set up for an appointment. During the meetup session, study information sheets and further elaboration on the study procedure were given to all participants before written consent was obtained from each of them.

Metabolic syndrome definitions and measurements

In this study, prevalence of MetS was first investigated by using the World Health Organization (WHO) (Alberti and Zimmet 1998), National Cholesterol Education Program Adult Treatment Panel (NCEP ATP-III) (National Institute of Health 2001), International Diabetes Federation (IDF) (International Diabetes Federation 2006) and Harmonized diagnostic definitions (Alberti et al. 2009). However, only the Harmonized definition was used for further analysis and reports regarding MetS prevalence. As suggested by the Harmonized criteria, MetS was diagnosed among breast cancer survivors with at least three out of five metabolic abnormalities. Additionally, breast cancer survivors who have been previously diagnosed with type II diabetes mellitus, or those who were on lipid and antihypertensive medication were also considered in these metabolic abnormalities. Anthropometric measurements were conducted with subjects in light clothing. Waist circumference, height and weight were assessed according to the WHO protocol (WHO 1995). Briefly, waist circumference was measured to the nearest 0.1 cm at the iliac crest by using SECA 201 measuring tape (SECA GmbH & Co. KG, Hamburg, Germany). Height measurement of the breast cancer survivors was taken to the nearest 0.5 cm by using SECA 217 mobile stadiometer (SECA GmbH & Co. KG, Hamburg, Germany) while they were standing straight with heels together, arms to the side and head in the Frankfurt horizontal plane (Lee and Nieman 2013).

Weight and body fat percentage were measured to the nearest one decimal place using TANITA breast cancer-543 body composition monitor (TANITA Corporation, Tokyo, Japan) while the subjects were standing still with weight equally distributed on both feet. To obtain the blood pressure data, OMRON HEM-7203 electronic blood pressure monitor (OMRON Corporation, Kyoto, Japan) was used. All subjects were in a seated position and the measurements were taken after a 5-minute rest. All anthropometric and blood pressure measurements were repeated two times and the average measurements were recorded. The body weight and height data were used to calculate and categorized the body mass index (BMI) (kg/m^2) of the subjects according to the WHO classification (WHO 1995). Laboratory analyses of the blood samples were carried out to obtain data on levels of triglycerides, high-density lipoprotein cholesterol (HDL-c) and fasting blood glucose. Meanwhile, low-density lipoprotein cholesterol (LDL-c) level was calculated using the Friedewald formula. The fasting blood glucose and lipid profiles analyses were conducted by using a fully-automated chemistry analyzer Olympus AU 400 (Olympus Corporation, Tokyo, Japan) with standard enzymatic and colorimetric methods. Information on sociodemographic profiles of the breast cancer survivors was acquired by using a self-administered questionnaire, whereas additional clinical and treatment data were obtained from the patients' medical records.

Statistical analyses

Descriptive statistics were used to summarize demographic, anthropometric, biochemical and clinical data of the study sample. Parameters with normal data distribution were reported as mean with standard deviation, while others were reported as the median and interquartile range (IQR). To compare the differences in clinical, metabolic, sociodemographic and anthropometric characteristics according to MetS status, statistical analyses to compare two independent groups were used, and the *p*-value of each

analysis was recorded. Statistical analysis was conducted by using IBM SPSS for Windows software, version 23.0 (IBM Corp, Armonk, NY, USA).

Results

Characteristics of breast cancer survivors

Table 1 shows the characteristics of all breast cancer survivors that were included in this study. Overall, the mean age ± SD of the subjects was 53.7 ± 7.6 years. Most of the cancer survivors were Malay (92.6%), married (72.9%), housewives (34.7%), had a maximum education level of secondary schools (64.2%) and a monthly income of less than RM1000 (36.8%). Next, majority of the cancer survivors were postmenopausal (87.4%), had prior experience of breastfeeding (88.4%), did not undergo hormone replacement therapy (83.2%) and had no family history of breast cancer (72.6%). Additionally, more than half of the breast cancer survivors did not take any oral contraceptive pill (54.7%). As there was no smokers or alcohol-drinkers among the breast cancer survivors, the link of these lifestyle factors with the presence of MetS could not be investigated.

Table 1

Characteristics of breast cancer survivors included in this study

Characteristics	Total (n = 95)	MetS (n = 48)	Non-MetS (N = 47)	p
Sociodemographic profiles				
Age [a]	53.7 (7.6)	55.1 (7.9)	52.4 (7.2)	0.082
Ethnic				
Malay	88 (92.6)	45 (93.8)	43 (91.5)	0.714
Chinese	7 (7.4)	3 (6.3)	4 (8.5)	
Marital status				
Single	3 (3.2)	0 (0)	3 (6.4)	0.262
Married	74 (77.9)	37 (77.1)	37 (78.7)	
Divorced	2 (2.1)	1 (2.1)	1 (2.1)	
Others	16 (16.8)	10 (20.8)	6 (12.8)	
Education				
Primary	6 (6.3)	2 (4.2)	4 (8.5)	0.214
Secondary	61 (64.2)	34 (70.8)	27 (57.4)	
Tertiary	28 (29.5)	12 (25.0)	16 (34.0)	
Occupation				
Professional	22 (23.2)	8 (16.7)	14 (29.8)	0.106
Support staff	10 (10.5)	6 (12.5)	4 (8.5)	
Self-employed	17 (17.9)	13 (27.1)	4 (8.5)	
Housewife	33 (34.7)	14 (29.2)	19 (40.4)	
Pensioner	13 (13.7)	7 (14.6)	6 (12.8)	
Menopausal status				
Premenopausal	12 (12.6)	5 (10.4)	7 (14.9)	0.511
Postmenopausal	83 (87.4)	43 (89.6)	40 (85.1)	
Breastfeeding				
Yes	84 (88.4)	44 (91.7)	40 (85.1)	0.318
No	11 (11.6)	4 (8.3)	7 (14.9)	

Characteristics	Total (n = 95)	MetS (n = 48)	Non-MetS (N = 47)	p
Oral contraceptive pills				
Yes	43 (45.3)	19 (39.6)	24 (51.1)	0.261
No	52 (54.7)	29 (60.4)	23 (48.9)	
Hormone replacement therapy				
Yes	16 (16.8)	6 (12.5)	10 (21.3)	0.253
No	79 (83.2)	42 (87.5)	37 (78.7)	
Family history of breast cancer				
Yes	26 (27.4)	14 (29.2)	12 (25.5)	0.691
No	69 (72.6)	34 (70.8)	35 (74.5)	
Clinical and metabolic profiles				
Cancer stages				
I	15 (15.8)	7 (14.6)	8 (17.0)	0.019*
II	55 (57.9)	34 (70.8)	21 (44.7)	
III	25 (26.3)	7 (14.6)	18 (38.3)	
Cancer duration (years) [a]	6.65 (4.19)	7.23 (5.22)	6.06 (2.71)	0.177
Treatments				
Surgery [b]	94 (98.9)	48 (100)	46 (97.9)	0.495
Chemotherapy	95 (100)	48 (100)	47 (100)	-
Radiotherapy	86 (90.5)	41 (85.4)	45 (95.7)	0.086
Comorbidities [d]				
Diabetes	17 (17.9)	13 (27.1)	4 (8.5)	0.018*
Hypertension	21 (22.1)	15 (31.3)	6 (12.8)	0.030*
Heart disease [b]	2 (2.1)	1 (2.1)	1 (2.1)	1.000
Metabolic profiles [c]				
Total cholesterol (mmol/L)	6.1 (1.6)	6.0 (1.4)	6.2 (1.6)	0.250
LDL-c (mmol/L)	3.8 (1.5)	3.7 (1.3)	4.0 (1.6)	0.195
HDL-c (mmol/L)	1.4 (0.4)	1.3 (0.4)	1.5 (0.5)	< 0.001*

Characteristics	Total (n = 95)	MetS (n = 48)	Non-MetS (N = 47)	*p*
TG (mmol/L)	1.5 (0.8)	1.8 (0.9)	1.3 (0.6)	< 0.001*
FBG (mmol/L)	5.7 (1.9)	6.5 (3.0)	5.0 (0.9)	< 0.001*
Systolic BP (mmHg)	128 (19)	134 (25)	124 (12)	0.006*
Diastolic BP (mmHg)	79 (13)	80 (13)	78 (11)	0.020*
Anthropometric profiles				
Weight (kg) [a]	66.0 (12.4)	68.7 (10.0)	63.3 (14.0)	0.032*
Height (cm) [a]	153.9 (6.0)	154.1 (5.1)	153.6 (6.9)	0.711
Waist circumference (cm) [a]	88.8 (11.7)	92.2 (9.9)	85.3 (12.4)	0.003*
Body fat percentage (%) [d]	39.0 (6.9)	40.5 (7.7)	38.2 (8.0)	0.020*
BMI (kg/m^2) [a]	27.9 (4.9)	29.0 (4.3)	26.7 (5.2)	0.023*
BMI classification (kg/m^2) [b]				
Underweight	3 (3.2)	0 (0)	3 (6.4)	0.138
Normal	20 (21.1)	8 (16.7)	12 (25.5)	
Overweight	43 (45.3)	22 (45.8)	21 (44.7)	
Obese	29 (30.5)	18 (37.5)	11 (23.4)	
Data in number (%), *p*-value derived using Chi-square test				
[a] Data in mean (SD), *p*-value derived using Independent t-test				
[b] Data in number (%), *p*-value derived using Fisher's Exact test				
[c] Data in median (IQR), *p*-value derived using Mann-Whitney test				
[d] The number of subjects without these comorbidities and complications were not reported in this table				
*p < 0.05, significantly different				
BMI, Body mass index; BP, Blood pressure; FBG, Fasting blood glucose; HDL-c, High density lipoprotein cholesterol; LDL-c, Low density lipoprotein cholesterol; MetS, Metabolic syndrome; TG, Triglyceride				

The majority of the breast cancer survivors had stage II breast cancer (57.9%) and prolonged cancer survival duration, with the mean ± SD of 6.65 ± 4.19 years. Besides chemotherapy, most of them also had undergone surgery (98.9%) and radiotherapy (90.5%). As there was only a portion of breast cancer

survivors reported to also be diagnosed with diabetes (17.9%), the median of fasting blood glucose level of all breast cancer survivors was reported to be slightly exceeding the normal value of 5.5 mmol per litre. Following the WHO classification for BMI, majority of the breast cancer survivors were overweight (45.3%), followed by obese (30.5%), normal (21.1%), and underweight (3.2%). Moreover, the high mean of waist circumference (88.8 cm) and the median body fat percentage (39.0%) indicated that the majority of breast cancer survivors tend to have central obesity.

Prevalence of metabolic syndrome and abnormal metabolic syndrome components

The overall prevalence of MetS among breast cancer survivors according to the Harmonized 2009, IDF 2005, ATP III 2001 and WHO 1998 criteria were reported to be 50.5%, 48.4%, 40.0% and 18.9% respectively (Table 2). When only the Harmonized criteria were considered, around half of the breast cancer survivor population in this study had two (25.3%) or three (26.3%) MetS components (Fig. 1). Meanwhile, Fig. 2 shows the number and percentage of subjects with abnormal MetS parameters in this study. Among all breast cancer survivors, the top three most prevalent abnormal MetS components were waist circumference (80.0%), fasting blood glucose (51.6%) and blood pressure (46.3%), whereas breast cancer survivors with MetS had the highest tendency to have abnormal triglyceride level (91.2%), fasting blood glucose (79.6%) and HDL-c (78.4%).

Table 2

Prevalence of metabolic syndrome according to different diagnostic definitions

MetS diagnostic definition	All (n = 95) n (%)	95% Confidence Interval
Harmonized (2009)	48 (50.5)	40.6−60.3
IDF (2005)	46 (48.4)	38.6−58.3
NCEP ATP III (2001)	38 (40.0)	30.7−50.0
WHO (1999)	18 (18.9)	12.3−27.9
IDF, International Diabetes Federation; MetS, Metabolic syndrome; NCEP ATP III, National Cholesterol Education Program Adult Treatment Panel III; WHO, World Health Organization		

Characteristics of breast cancer survivors according to metabolic syndrome status

Analysis of the characteristics of all research participants showed no significant difference in all reported sociodemographic profiles between those with and without MetS. Meanwhile, breast cancer survivors with MetS had significantly higher levels of triglyceride ($p < 0.001$), fasting blood glucose ($p < 0.001$), systolic blood pressure ($p = 0.006$) and diastolic blood pressure ($p = 0.020$), as well as a significantly lower level of HDL-c ($p < 0.001$). In contrast, the total cholesterol and LDL-c levels were not significantly

different among those with and without MetS. Significant difference between cancer stages and MetS was also found (X^2 (2) = 7.97, p = 0.019). In addition, breast cancer survivors with MetS had significantly higher body weight (p = 0.032), waist circumference (p = 0.003), BMI (p = 0.023) and body fat percentage (p = 0.020).

Discussion

MetS has been recognized as an important secondary target for the prevention of cardiovascular diseases and diabetes, as well as reducing the mortality rate among cancer survivors. In this study, the Harmonized MetS definition that has been proposed in 2009 was used as a simple, useful and most updated guideline to diagnose MetS. Moreover, MetS prevalence was also reported by using WHO, ATP III and IDF diagnostic definitions for easier interpretation and comparison with other studies.

In this study, the prevalence of MetS among breast cancer survivors in East Coast of Peninsular Malaysia showed a higher percentage of subjects with MetS, up to half of the proportion of the investigated breast cancer survivors. When compared with the recent report by The Malaysian Breast Cancer Survivorship Cohort (MyBCC) study on the prevalence of MetS among newly-diagnosed breast cancer patients in UMMC, higher proportion of breast cancer survivors with MetS was reported in the current study – 48.4% in the current study against 37.8% in MyBCC study as according to IDF 2005 definition (Kiew et al. 2018). This difference can be attributed to the variation in breast cancer survival duration and ethnic composition percentage among the breast cancer survivors between these two studies. Furthermore, MetS prevalence among breast cancer survivors as reported in the current study was also similar, or higher than the data reported in other countries such as India – NCEP ATP III definition: 40.0% vs 40.0% respectively (Wani et al. 2017), China – Harmonized definition: 50.5% vs 32.6% (Wu et al. 2018), Korea – Harmonized definition: 50.5% vs 43.9% (Lee et al. 2013), USA – Harmonized: 50.5% vs 26.1% (Calip et al. 2014), Denmark – NCEP ATP III definition: 40.0% vs 15.1% (Fredslund et al. 2019) and Brazil – Harmonized definition: 50.5% vs 48.1% (Nahas et al. 2012) respectively. The higher proportion of breast cancer survivors with MetS in Asian countries as compared to Western countries reflected that MetS has become more prevalent in developing countries when compared to its Western counterparts due to increasing economic development in lower to middle-income countries (Saklayen 2018; Ranasinghe et al. 2017).

Contrarily, MetS prevalence among general women population had also been reported in numerous studies. In Malaysia, MetS prevalence among general Malaysian women in three nationwide studies were reported to range between 30.1% – 43.7%% (Mohamud et al. 2011; Rampal et al. 2012; Tan, Dunn, and Yen 2011). Besides, MetS prevalence among specific populations have also been reported, including among Kelantanese women (IDF definition: 32.2–36.6%) (Jan Mohamed et al. 2013; Zainuddin et al. 2011), aborigines 'Orang Asli' women (Harmonized definition: 23.8%) (Ashari et al. 2016), women in urban and rural areas (IDF definition: 10.8–39.3%) (Ramli et al. 2013; Bee, Haresh, and Rajibans 2008), female university staff (NCEP ATP III definition: 21.4–45.3%) (Heng et al. 2013; Chu and Moy 2013; Moy and Bulgiba 2010) and female government workers (Harmonized definition: 46.3%) (Chee et al. 2014).

Comparatively, higher prevalence of MetS was observed among the breast cancer survivors than the general women population, which supported previous reports describing the tendency of breast cancer survivors to be diagnosed with MetS (Bao et al. 2013; Bhandari et al. 2014).

Previous studies conducted in Malaysia (Mohamud et al. 2011), India (Subramani et al. 2019), Taiwan (Lin et al. 2019) and Australia (Mitchell et al. 2018) have shown that the Harmonized criteria displayed a higher percentage of people with MetS than other MetS definition. Subsequently, more people could benefit from a prevention-based intervention program focusing on reducing the development of cardiovascular diseases and diabetes (Mohamud et al. 2011). When compared with other MetS diagnostic criteria, the Harmonized definition has the advantage of not having the cut-off points of waist circumference designed for the Western population as in the ATP III definition (Alberti et al. 2009; International Diabetes Federation 2006).

Additionally, Harmonized criteria do not have central obesity as a requisite condition to diagnose MetS like in IDF criteria, hence avoiding underestimation of MetS prevalence due to low predictive value of waist circumference with cardiovascular risk (Mohamud et al. 2011; Katzmarzyk et al. 2006). In terms of the agreement between different MetS definition, one of the previous study conducted among Malaysian adult showed that the Harmonized definition exhibited good concordance with WHO and ATP III definitions (Tan et al. 2013). However, another study also conducted among Malaysian adults reported better agreement between Harmonized and IDF definitions (Ramli et al. 2013).

In the present study, among those with MetS as according to the Harmonized MetS definition (≥ 3 criteria), more than half of them met three MetS components, whereas 31.3% and 16.6% met four and five components respectively. However, when compared among all breast cancer survivors included in this study, the percentage of women meeting two MetS components (25.3%) was almost similar to those meeting three MetS components (26.3%). Furthermore, studies conducted among adults in China (Li et al. 2018), Thailand (Aekplakorn et al. 2011), Netherland (Zając-Gawlak et al. 2017) and Nepal (Mehata et al. 2018) also reported an almost similar, or even higher percentage of adults with two MetS components. If left with no intervention, this group of breast cancer survivors that was just below the borderline of MetS diagnosis would have a higher tendency to have a worse health condition or even being diagnosed with MetS in the future. Particularly, breast cancer survivors have been reported to have higher weight after a cancer diagnosis as compared to a year before being diagnosed with breast cancer (Mohammadi et al. 2013; Yaw et al. 2010).

Moreover, the most prevalent abnormal MetS parameters among all breast cancer survivors were abdominal obesity, followed by hyperglycemia and hypertension. Previous studies have also reported an almost similar trend of the top three most prevalent abnormal MetS parameters (Li et al. 2018; Mitchell et al. 2018; Muniz, Kidwell, and Henry 2016; Sun et al. 2018). As increased waist circumference has been reported to be closely related with excess adiposity, impaired insulin sensitivity and other cardiometabolic factors, incremental changes in waist circumference would have detrimental effects to other MetS components (Poirier et al. 2005; Balkau et al. 2007). Moreover, increased blood pressure was also

associated with central body fat distribution, independent of BMI and insulin resistance (Siani et al. 2002). Meanwhile, dyslipidemia and hyperglycemia were more prevalent among breast cancer survivors with MetS. Therefore, targeting these conditions in the clinical settings should be the utmost priority in the effort to reduce MetS-related morbidity and mortality among breast cancer survivors in East Coast of Peninsular Malaysia.

Meanwhile, previous literatures have described the links between MetS and other sociodemographic and lifestyle factors among Malaysian adults, such as higher age, unemployment, working in shifts, postmenopausal status, living in urban area, lower socioeconomic status, Indian ethnicity, Chinese ethnicity and lower education level (Kiew et al. 2018; Jan Mohamed et al. 2013; Ching et al. 2018; Mohamud et al. 2011; Rampal et al. 2012; Lim and Cheah 2016; Ramli et al. 2013; Tan, Dunn, and Yen 2011). Specifically, these factors can be linked with other modifiable risk factors of MetS such as physical inactivity and unhealthy diets. According to Malaysian National Health and Morbidity Survey (NHMS) 2015, lower prevalence of physical activity was observed among older adults, Chinese ethnicity, those living in urban areas, having no formal education, retiree and lower household income (Institute for Public Health 2015). Additionally, other studies have also reported physical inactivity among Indian ethnicity (Tan, Dunn, and Yen 2011). The NHMS 2015 survey also reported less intake of fruits and vegetables among Malays, those living in urban areas, having no formal education and middle-income group (Institute for Public Health 2015).

Similar to the findings of previous research, this study reported significant links between MetS and increased body weight (Ching et al. 2018; Moreira et al. 2014; Ortiz-Rodríguez et al. 2017), waist circumference (Johari and Shahar 2014; Ortiz-Rodríguez et al. 2017; Raposo et al. 2017), body fat percentage (Johari and Shahar 2014; Ortiz-Rodríguez et al. 2017) and BMI (Wu et al. 2018). However, we did not find a significant difference across MetS status in any specific sociodemographic profile, total cholesterol level or LDL-c level. The differences in our findings may be attributed to several limitations of the study which should be addressed properly. Firstly, the breast cancer survivors included in this study were recruited only from Terengganu and Kelantan, hence the findings of this study might not represent all breast cancer survivors in Malaysia. Additionally, due to the sociodemographic characteristic and racial distribution of breast cancer survivors in Terengganu and Kelantan, data on breast cancer survivors from other ethnicities were very scarce, hence analysis on ethnicities and MetS in this study was very limited. It is also important to note the possibility that breast cancer survivors that agree to participate in this research might have more health-awareness compared to non-participants. Similarly, other important risk factors such as physical activity and dietary intake were not reported in this study. Therefore, the links and their confounding effects on MetS could not be determined.

To the best of our knowledge, this is the first study to report the prevalence of MetS among breast cancer survivors in East Coast of Peninsular Malaysia. As MetS prevalence in this study was reported using several diagnostic definitions, comparison with other studies can be easily done using any of these diagnostic definitions.

Conclusion

MetS prevalence among breast cancer survivors in East Coast of Peninsular Malaysia was 50.5%, which is higher than normal population and in need of urgent attention. Majority of breast cancer survivors in this study had abdominal obesity, and dyslipidemia was the most prevalent MetS parameter among those with MetS. Additionally, MetS were significantly associated with higher weight, BMI, waist circumference, and percent body fat. Relatively high MetS prevalence among normal and underweight individuals should also be noted. Additionally, the association between MetS and other lifestyle factors like physical activity and dietary intake should also be considered, as insufficient physical activity level, increased sedentary behavior and imbalance dietary intake are important risk factors for MetS as well. Meanwhile, in clinical settings, it is recommended to give utmost priority in improving triglycerides, blood glucose and HDL-c level of the breast cancer survivors in Malaysia to control MetS.

Declarations

Ethics approval and consent to participate

This research has been performed in accordance with the Declaration of Helsinki and ethical approval was obtained from the Ministry of Health, Malaysia (NMRR-14-1618-23717 (IRR). Informed consent to participate in the study was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request

Competing interest

The authors declare that they have no competing interests.

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Authors' contributions

MRS, PLL, AA and SS made substantial contributions to the conception and design of the work; VL, AN, NSZ and SA made substantial contributions to acquisition and analysis of data; SA and MRS made

substantial contributions to interpretation the data; SA has drafted the work; MRS, PLL and AA have substantively revised it. All authors have approved the submitted version and agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Figures
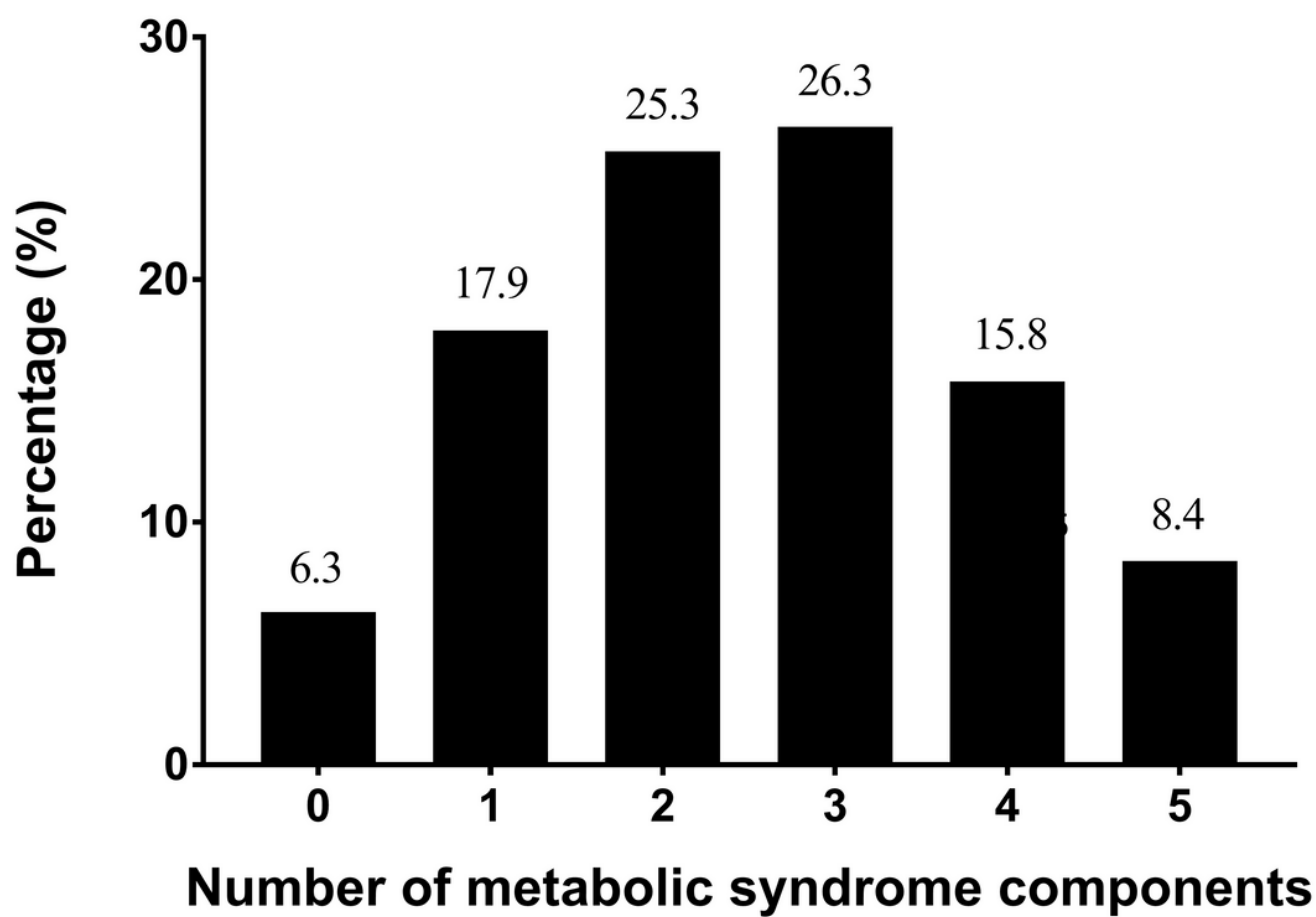
Figure 1

Metabolic syndrome component according to Harmonized criteria
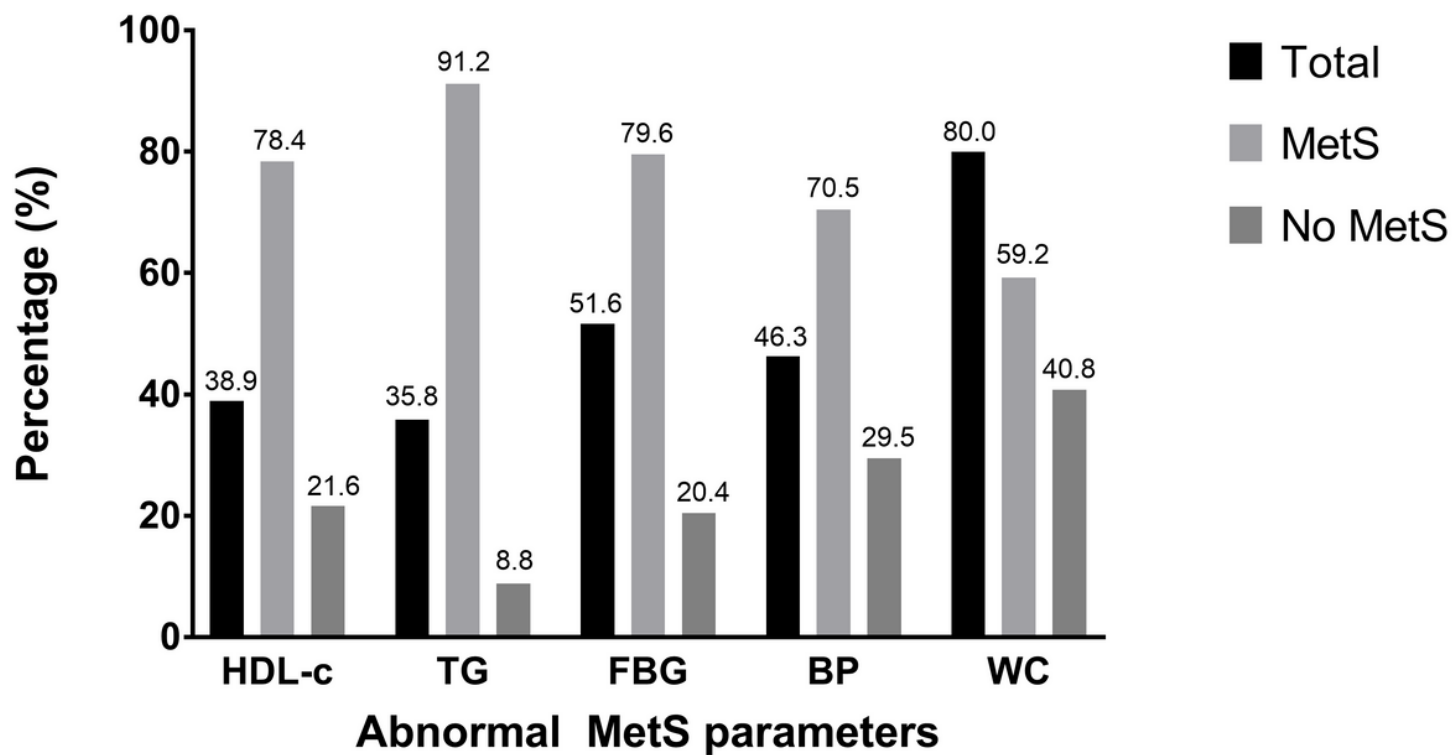
Figure 2

Abnormal metabolic syndrome parameters