

UNIVERSITI SAINS MALAYSIA



**THE ASSOCIATION BETWEEN BODY
COMPOSITION MEASUREMENTS AND BLOOD
PRESSURE AMONG ADULTS IN TAWANG,
BACHOK KELANTAN**

by

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**Dissertation submitted in partial fulfillment of
the requirements for the degree
of Bachelor of Health Sciences (Nursing)**

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CERTIFICATE

This is to certify that the dissertation entitled 'The Association between Body Composition Measurements and Blood Pressure among Adults in Tawang, Bachok Kelantan' is the bonafide record of research work done by Hafidah Binti Zolkepli, Matric Number 87432 during the period of July 2008 to April 2009 under my supervision. This dissertation submitted in partial fulfillment for the degree of Bachelor of Health Sciences (Nursing). Research work and collection of data belong to Universiti Sains Malaysia



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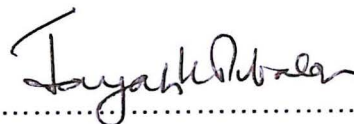
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THE ASSOCIATION BETWEEN BODY COMPOSITION MEASUREMENTS AND BLOOD PRESSURE AMONG ADULTS IN TAWANG, BACHOK KELANTAN

ABSTRACT

This study investigated the association between body composition measurements and blood pressure and also to determine measures that strongly associated to blood pressure among adults in Tawang, Bachok Kelantan. This was a cross-sectional study of sixty three adults, aged between 18 to 59 years, 21 males and 42 females. This subject underwent measurement of weight and height, waist and hip circumference, body fat and visceral fat, and blood pressure. Body fat and visceral measurement was carried out through electric bioimpedance, using a Tanita body fat analyzer BC 545. Waist and hip circumference were also measured. Pearson correlation analysis was used to study the correlation of each body composition measurement with blood pressure while the stepwise multiple linear regression was used in this study to analyse the body measurement that best explained blood pressure. There is significant association between Body Mass Index (BMI) and blood pressure ($P < 0.01$, $r = 0.327$). Whereas, no relationship between Waist Hip Ratio (WHR) and Blood Pressure. The percentage of body fat was also significantly correlated with blood pressure. As a conclusion, among these three measurements, the measure that strongly associated to blood pressure in this study among adults in Tawang was BMI. Otherwise, this study also revealed that the hip circumference and waist circumference were the best simple anthropometric index to assess the adult of high risk individual with cardiovascular disease together with BMI.

KAITAN ANTARA PENGUKURAN KOMPOSISI BADAN DAN TEKANAN DARAH DALAM KALANGAN INDIVIDU DEWASA DI KAMPUNG TAWANG, BACHOK

ABSTRAK

Kajian ini adalah untuk meninjau perkaitan antara pengukuran komposisi badan dan tekanan darah dalam kalangan orang dewasa di Tawang, Bachok Kelantan. Selain itu, ia juga bertujuan untuk mengenalpasti pengukuran terbaik yang paling mempengaruhi tekanan darah dalam kalangan dewasa. Kajian ini berbentuk keratan lintang dengan saiz sampel seramai 63 orang, 21 lelaki dan 42 perempuan yang berumur antara 18 hingga 59 tahun. Subjek menjalani pengukuran Indeks Jisim Tubuh (IJT), lilitan pinggang dan pinggul, tekanan darah, dan juga peratusan lemak badan dan lemak organ yang diambil menggunakan 'Tanita Body Fat Analyser BC 545'. Perkaitan antara pengukuran komposisi badan dan tekanan darah dianalisis menggunakan analisis 'Pearson Correlation' dan pengukuran yang terbaik yang menerangkan tekanan darah dianalisis dengan 'Stepwise Multiple Linear Regression'. Keputusan kajian menunjukkan Indeks Jisim Tubuh (IJT) ($P < 0.01$, $r = 0.3$) mempunyai kaitan dengan tekanan darah tetapi nisbah lilitan pinggang dan pinggul tiada menunjukkan perkaitan dengan tekanan darah. Walau bagaimanapun, lilitan pinggang dan lilitan pinggul masing-masing mempengaruhi tekanan darah dan mempunyai kaitan dengan tekanan darah. Kesimpulannya, Indeks Jisim Tubuh (IJT) adalah pengukuran terbaik yang paling mempengaruhi tekanan darah dikalangan dewasa apabila dibandingkan dengan nisbah lilitan pinggang dan pinggul dan peratus lemak badan. Di dalam kajian ini juga mendapati pengukuran lilitan pinggul dan pengukuran lilitan pinggang masing-masing menunjukkan pengukuran yang baik dan mampu meninjau risiko penyakit jantung dikalangan dewasa bersama sama Indeks Jisim Tubuh (IJT).

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Malaysia is one of the countries which have the highest prevalence of overweight and obesity in the Asian region (Ismail, 2002). As Malaysia proceeds rapidly towards a developed economy status, overweight and obesity in Malaysia are rising rapidly and has become the public health concern (Ismail, 2002). The impact of obesity on the public health status is reflected by the increasing prevalence of chronic diseases amongst Malaysian (Ismail, Chee, Nawawi, Yusoff, Lim & James, 2002). The effect of the population's health status will be particularly severe if the sedentary lifestyle of its population continues (Ismail et al., 2002). Changes in dietary habits and sedentary lifestyles are associated with modernisation and increase in the standard of living (Ismail et al., 2002).

Worldwide, the prevalence of overweight and obesity is increasing at an alarming rate (Doak, Visscher, Renders & Seidell, 2006). Now, 66% of United States adults are overweight or obese (Wang & Beydoun, 2007). Between 2000 and 2005, the prevalence of obesity in the USA increased by 24%, while the number of severely obese [body mass index (BMI) > 40] cases increased by 50% (Sturm, 2008).

Cardiovascular diseases (CVD), cancer, and diabetes mellitus are examples of chronic diseases which is related to overweight and obesity that will be responsible to death (Rueda-Clausen, Silva & Lopez-Jaramillo, 2008). By 2020, (CVD) will be responsible for 57% of all deaths worldwide (WHO, 2006). China, the most populous

country in the world, is also facing an epidemic of diabetes and obesity (Avenida & Mackenbach 2006; Yoon, Lee, Kim, Cho, Choi, Ko, Zimmet & Son, 2006). There are now 40 million people with diabetes in China (Donnelly, Wang & Qu, 2006), whose total population is 1.3 billion.

Among the Malaysian adults, 20.7% were overweight and 5.8% obese (0.3% of whom had BMI values of $>40.0\text{kgm}^2$) (Ismail et al., 2002). Obesity appears to be more prevalent in women than men (Ismail et al., 2002). In women, obesity rates were higher in Indian and Malay women than in Chinese women, while in men the Chinese recorded the highest obesity prevalence followed by the Malay and Indians (Ismail et al., 2002). There are several risk factors for females and males to become overweight and obesity. It is significantly associated with older age, not being in a marriage-like relationship, low education, physical inactivity, and poor dietary intake (Brown & Siahpush, 2007).

Overweight and obesity are related to a number of health consequences such as diabetes and CVD. One of the consequences is elevated blood pressure (Pang, Sun, Zheng, Li, Zhang, Liu, Xu, Li, Hu & Sun, 2008). It is also known as hypertension. Hypertension is a major public health problem in Malaysia. In 1996, the prevalence of high blood pressure (BP $>140/90$) amongst adults 30 years and above is estimated to be 29.9% (National Health & Morbidity Survey 2, 1996)

1.2 Problem Statement

Overall, more than 1 billion people throughout the world are overweight (WHO, 2007) and obesity is estimated to affect some 130 million adults (WHO, 2006). Overweight and obesity in most countries throughout the world are predicted to continue rising if not addressed (Knai, Suhrcke & Lobstein, 2007). Related to the continuity rising of overweight and obesity, it has been associated with a dramatic increase in related healthcare costs (Henry, 2003). This is because of the detrimental effect of obesity to the

health. Obesity linked to increase the risk of cardiovascular disease (CVD), diabetes, certain cancers and other debilitating conditions (Tanita, 2000). The risk of CVD for millions of people worldwide increases related to the high blood pressure (Carretero & Oparil, 2000). One of the factors that increase blood pressure is obesity and it is known as hypertensinogenic factor pressure (Carretero & Oparil, 2000). Thus, obesity is an important cardiovascular health problem.

Therefore, the conceptual framework on association between body fat and hypertension has been used in this study. It is focus on the increase of Body Mass Index (BMI) and body fat that significantly cause of obesity. The recognition of obesity (whether assessed by BMI or percentage body fat) and central obesity (assessed by WC or WHR) (Al Sendi et al., 2003). Subsequently, obesity cause health problems such as diabetes mellitus, dyslipidemia and hypertension (Neutzling, Taddei & Gigante, 2003)

1.3 Objective

1.3.1 General Objective

1. To investigate the associations between body measurements and blood pressure among adults living in Tawang, Bachok.

1.3.2 Specific Objective

- 1) To investigate the association between body mass index and blood pressure in adults.
- 2) To investigate the association between body fat composition and blood pressure in adults.
- 3) To investigate the association between waist hip ratio and blood pressure in adults.
- 4) To determine measures that strongly associated to blood pressure in adults.

1.4 Research Questions

1. Are there any association between body mass index and blood pressure in adults?
2. Are there any association between body fat composition and blood pressure in adults?
3. Are there any association between waist hip ratio and blood pressure in adults?
4. Which is the body measurement that is strongly associated with blood pressure in adults?

1.5 Hypothesis

1. There is no significant association between body mass index and blood pressure in adults.
2. There is no significant association between body fat composition and blood pressure in adults
3. There is no significant association between waist-hip-ratio and blood pressure in adults.

1.6 Definition of Terms

1.6.1 Body Composition

Measuring body composition can more accurately assess fat distribution. Body composition is used to describe the percentages of body fat, fat free mass, muscle, bone density, hydration or other components in human bodies (Tanita, 2000). It can be measured by several ways such as using calipers or skin fold measurement, hydro densitometry (underwater weighing), bioelectric impedance, near-infrared interaction, and Dual energy X-Ray Absorptiometry (Tanita, 2000).

Skin fold thickness is measured using Harpenden calipers at four sites (triceps, biceps, subscapula and suprailiac crest) on the non-dominant side of the body (Jebb, Cole, Doman, Murgatroyd & Prentice, 2000). In hydro densitometry method, it measures whole body density by determining body volume (Tanita, 2000). As a result from this method, a person with more bone muscle will weight more in water, meaning they have higher bone density and lower percentage of body fat (Tanita, 2000).

Body impedance is measured when a small, safe electrical signal is passed through the body, carried by water and fluids (Tanita, 2000). While, the near-infrared interaction method has become the popular outside of the laboratory because it is simple, fast, noninvasive, and the equipment is relatively inexpensive. The gold standard method to measure body composition is dual energy X-Ray Absorptiometry (DEXA) (Tanita, 2000). DEXA is a new technology that is very accurate and precise (Tanita, 2000) but it is expensive to use. This technique is used to estimate the bone mineral, fat and fat-free soft tissue mass (Jebb et al., 2000).

1.6.2 Blood Pressure

Blood pressure is a continuous variable, and risks of various adverse outcomes rise with it. Blood pressure is the force of blood pushing against the walls of the arteries as the heart pumps out blood. If this pressure rises and stays high over time, it can damage the body in many ways (National Heart Lung and Blood Institute, 2008). Blood pressure is at its highest when the heart beats, pumping the blood. This is called systolic pressure. When the heart is at rest, between beats, your blood pressure falls. This is the diastolic pressure (National Heart Lung and Blood Institute, 2008).

A blood pressure of less than 120/80 mmHg is defined as optimal in adults. High blood pressure or hypertension was defined as an average systolic blood pressure ≥ 140 mmHg, an average diastolic blood pressure ≥ 90 mmHg or both (JNC VI, 1997). Systolic and diastolic blood pressures were evaluated using a properly calibrated aneroid

manometer (Oliveira, Gusmao, Nakamoto, Souza, Sa, Pestana & Lima, 2005) or an electric sphygmomanometer (Pang et al., 2008). For calibrated aneroid manometer, systolic blood pressure was recorded with the appearance of the first sound (phase 1), while the disappearance of sound (phase 5) was used to define diastolic blood pressure (Oliveira 2005). Overweight and obesity individual has more high mean systolic and diastolic blood pressure than normal weight people (Pang et al. 2008).

Table 1.1: Definitions and Classification of Blood Pressure Levels

Category	Systolic, mm Hg		Diastolic, mm Hg
Optimal	< 120	and	< 80
Normal	< 130	and	< 85
High normal	130–139	or	85–89
Hypertension			
Stage 1 (mild)	140–159	or	90–99
Subgroup: borderline	140–149	or	90–94
Stage 2 (moderate)	160–179	or	100–109
Stage 3 (severe)	≥ 180	or	≥ 110
Isolated systolic hypertension	≥ 140	and	< 90
Subgroup: borderline	140–149	and	< 90

(JNC VI 1997)

When a patient's systolic and diastolic blood pressures fall into different categories, the higher category should apply.

1.6.3 Definition of Obesity

According to the World Health Organization, obesity is a disease and is defined as the condition of excess body fat to the extent that health is impaired. The definition of overweight and obesity is having a BMI value higher than 25 and 30 kg/m², respectively (Elbers, Onland-Moret, Franke, Niehoff, van der Schouw, & Wijmenga, 2007). BMI (weight (kg)/ height (m)²) is now widely used to assess obesity (WHO, 2000). Currently, the BMI cut points to define overweight and obesity by World Health Organization are 25 and 30kg/m², respectively (WHO Expert Committee, 1995).

However, several researchers questioned the BMI classification, as it is found to be more accurate for Western population (Reynolds, Gu, Whelton, Wu, Duan, Mo & He, 2007). It was suggested that Asians should have a lower cut-off value for overweight and obesity classification due to smaller body stature (Wildman, Gu, Reynolds, Duan, & He, 2004). The argument was that people with larger frame have greater mass overall but lower ratio of lean mass over fat mass (Wildman et al., 2004). This controversy has triggered for the search of other body measurements that may better define fatness among Asian that can accurately define the risk of other co-morbidity.

Table 1.2: Classification of body weight based on body mass index (BMI)

Body weight classification	BMI range
Underweight	<18.5 kg/m ²
Normal weight	18.5–24.9 kg/m ²
Overweight	25–29.9 kg/m ²
Obesity (Class 1)	30–34.9 kg/m ²
Obesity (Class 2)	35–39.9 kg/m ²
Extreme obesity (Class 3)	≥40 kg/m ²

(WHO, 2000)

1.6.4 Central Obesity

Android or also known as apple shaped is more vulnerable to disease than those who are gynoid or pear shaped (Tanita, 2000). Premenopausal women typically have a lower body adipose distribution (gynoid) characterized by fat deposition in the gluteofemoral region. However, in men, an upper body adipose distribution (android) develops, which is characterized by central fat deposition in the abdominal intraperitoneal and subcutaneous regions (Thomas, Ho, Lam, Janus, Hedley & Lam, 2004). Before the age of 50, majority of women tend to increase their weight slowly, whereas after menopause there appears to be an accelerated increase in fat mass and a change in preferential fat storage to a central part of body that is abdominal location (Evans, Van Pelt, Binder, Williams, Ehsani & Kohrt, 2001) A number of alternative more practical methods were developed to assess intra-abdominal fat or central obesity. The waist-to-hip ratio (WHR) is a simple, yet accurate, method for determining your body fat pattern (Kissebah, 1996). WHR is determined by dividing the waist circumference by the hip circumference. Waist circumference is defined as the smallest circumference between the rib cage and belly button. Hip circumference is defined as the largest circumference of the hip-buttocks region (Gibson, 2003).

In the general population, WC is strongly and independently associated with multiple traditional risk factors for CVD, including diabetes, hypertension, and dyslipidemia. In men, a waist size of ≥ 40 " and in women ≥ 35 " is an indication of increase health risk (Tanita, 2000). Central obesity is defined as a $WC \geq 90$ cm for men and ≥ 80 cm for women as recently proposed by the International Association for the Study of Obesity (Zimmet, Magliano, Matsuzawa, Alberti & Shaw, 2005).

1.7 Significance of the Study

Early and accurate detection will be vital to curb the impact of cardiovascular disease in the future. The result of this study is helpful to individual at the risk of increase blood pressure for lower health care cost by reducing the need for frequent treatment of the obesity impact to the health. Therefore, understanding the association between body composition measurements and blood pressure is crucial for health professional as well as a nurse to apply this knowledge in clinical practice. It is also very important for health workers including nurses to know the most appropriate body measurement that is significantly associated with blood pressure. Efficient clinical practice requires guidelines for the identification of individuals who should be targeted for monitoring, prevention, and possible treatment and perhaps may prevent further detrimental effect of obesity to the health. Furthermore, aggressive promotion activities for creating awareness have to be carried out in the community with regular screening of blood pressure need to be advocated tirelessly to the public. So, the prevention and management of high blood pressure continues to be a major challenge to healthcare providers. The relationship of the best body composition measurement and blood pressure is then need to be study to target the high risk individual.

CHAPTER 2

LITERATURE REVIEW

2.1 Body measurements

BMI, waist circumference and waist to-hip ratio (WHR) are commonly used indirect anthropometric indices of obesity in adults (Shaw, Srikanth, Fryer, Blizzard, Dwyer & Venn, 2007). It is ideal for use in large epidemiological studies because these measures are simple and standardized (Shaw et al., 2007). These measures have been found to be useful predictors of cardiovascular and all-cause mortality in one previous study (Welborn, Dhaliwal & Bennett, 2003).

However, how useful such indirect measures in adults aged between 18 till 60 years old is still has limited understanding. This is related to aging process that may changes in body composition, including a reduction in fat-free tissue mass (Visser, Pahor, Tylavsky, Kritchevsky, Cauley, Newman, Blunt.& Harris, 2003) and an increase in fat mass leading to a higher percentage of body fat at any given body weight in adults (Bedogni, Pietrobelli, Heymsfield, Borghi, Manzieri, Morini, Battistini & Salvioli, 2001).

Thus the validity of indirect anthropometric measures in measuring body composition will be affected because of these and other age-related changes (such as loss of skin elasticity, body cell mass and abdominal muscle bulk, and an increase in thoracic kyphosis) (Shaw et al., 2007).

Newer and more sensitive methods of measuring body composition hope will provide the high degree of accuracy. This study is one of the opportunities to study the

association between body fat composition and blood pressure among adults as well as to study the age-related changes in body composition.

Besides that, the study also aimed to clarify which of the body measurement is the best predictor of blood pressure in adults. The measures include body mass index, waist hip ratio and body composition. In this study, measures of body fat composition were obtained using indirect anthropometry and the more direct method of Tanita body composition analyser model BC 545.

2.2 Association between Simple Anthropometric Indices and Cardiovascular Risk Factors

Previous research has consistently shown that both absolute total fat and adipose tissue distribution are closely associated with the risks of diabetes, hypertension, hyperlipidemia and cardiovascular disease (Kannel, Cupples, Ramaswami, Stokes, Kreger & Higgins, 1991). Many studies discovered that fat distribution, rather than absolute total fat, is more closely associated with these risk factors (Jebb et al., 2000).

However, other studies found that total body fat or body mass index (BMI), rather than its distribution, is the stronger predictor of metabolic risks (Mykkanen, Laakso & Pyorala, 1992). Besides that, Waist-to-hip ratio (WHR) is so far the most widely used index of central fat distribution due to its benefits in routine monitoring and assessment in patients (Jebb et al., 2000). Furthermore, recent studies have shown that waist circumference (WC) is the best simple anthropometric index of abdominal visceral adipose tissue (Ferland, Despres, Tremblay, Pinault, Nadeau, Moorjani, Lupien, Theriault & Bouchard, 1989) and may also be the best index for predicting cardiovascular risks (Reeder, Senthilselvan, Despres, Angel, Liu, Wang, & Rabkin, 1997)

There is one previous study that aimed to clarify which of the three simple anthropometric indices which are BMI, WHR and WC is the best predictor of cardiovascular risk factors. Besides, this study is also to determine if the magnitude of association varies with gender in the study population (Ferland et al. 1989). The result revealed that BMI in men and WHR in women are the important anthropometric indices to predict metabolic syndrome (hypertension or diabetes or dislipidemia) (Al Sendi et al., 2003).

WC was also a significant predicting variable for both sexes. So, gender difference of the correlation of obesity pattern with metabolic risk factors was further confirmed (Shen, Punyanitya, Chen, Gallagher, Albu, Pi-Sunyer, Lewis, Grunfeld, Heshka & Heymsfield 2006). The conclusion of this study states that the association of obesity indices and cardiovascular risk factors varied with gender (Ferland et al. 1989). The strongest predictors of metabolic syndrome were central obesity for the female subgroup and general obesity for the male subgroup (Shen et al., 2006). Among the three studied anthropometric indices, WC was the best predictor of cardiovascular risk factors, especially for women (Ferland et al., 1989).

In previous studies of young adults, the indirect anthropometric such as BMI, WHR and WC are measures have been found to be useful predictors of cardiovascular and all-cause mortality (Welborn, Dhaliwal & Bennett, 2003). However, there is limited understanding of how useful such indirect measures are in older adults (Brodowicz, Mansfield, McClung & Althoff, 1994). So, by using bioelectrical impedance analysis (BIA) the population estimates of body composition in older adults were obtained in the third National Health and Nutrition Examination Survey (NHANES III) (Chumlea, Guo, Kuczmarski, Flegal, Johnson, Heymsfield, Lukaski, Friedl & Hubbard, 2002).

While more accurate than field methods of body composition assessment, BIA is less reliable in quantifying body composition under controlled conditions than dual-

energy X-ray absorptiometry (DXA) (Shaw et al., 2007). In this study BMI and waist circumference correlated more strongly with DXA body fatness than WHR (Visser et al., 2003). The researchers speculate that this may owe to changes in body composition that occur with increasing age. Loss of gluteal muscle bulk, loss of abdominal muscle tone and also shift of fat mass from a peripheral to a more central distribution are the changes include age-related (Visser et al., 2003). These changes may lead to increase in WHR in the absence of increase in total body fat.

In younger adults, waist circumference is a useful measure of abdominal obesity and is associated with prevalent diabetes and cardiovascular risk factors (Siani, Cappuccio, Barba, Trevisan, Farinaro, Lacone, Russo, Russo, Mancini & Strazzullo, 2002). It may be that waist circumference is a better measure in older adults than WHR. However, limitations to this study were the researcher unable to partition-measurement error in our body composition measures because repeat measurements were not made to test reliability (Shaw et al., 2007). Although, the possibility of measurement error was minimised in the study design because the personnel were trained in indirect anthropometric measurement and were required to adhere strictly to written protocols. Additionally, in studies of test–retest reliability, measurements from repeated DXA scans have been highly correlated (Koo, Massom, & Walters, 1995)

In other study, DEXA has been shown to provide accurate and precise measurements of bone mineral content, fat-free mass, and fat mass in subjects over a wide range of ages and body size (Bedogni et al., 2001). This method has been validated against a range of established techniques, including underwater weighing (Welborn, Dhaliwal & Bennett, 2003). This method also allows quantification of fat mass in anatomically defined regions of interest, which allows more precise evaluation of the impact of fat distribution (Brodowicz, 1994).

2.3 Conceptual Framework

The Associations between Body Fat and Hypertension

The dramatic increase in obesity in the worldwide over the past two decades is believed to be a consequence of social–environmental factors. It favour a positive energy balance resulting from increased energy intake and inadequate physical activity (PA) as well, overweight is related to dietary intake and physical activity, both of which are influenced by social, economic and physical environments (Pang et al., 2008). The previous study focused on family and individual factors such as eating and PA behaviours (Neutzling, Taddei, & Gigante, 2003).

Obesity is significantly influenced by the interplay of genetic factors and environmental conditions (Loos & Bouchard, 2003). It is because, the obesity arises when a long-term imbalance occurs between the consumption and expenditure of energy and when a positive energy balance emerges which leads to an excess storage of body fat (Weck & Fischer, 1997). Overweight and obesity were defined as a body mass index (BMI) of $>25 \text{ kg/m}^2$ (Rueda-Clausen, Silva & Lopez-Jaramillo, 2008). BMI is closely correlated with body fat and obesity related health consequences (Thomas et al., 2004). The health consequences associated with obesity is numerous cardiovascular disease risk factors, such as hypertension, dyslipidemia, type 2 diabetes, and insulin resistance (Wang & Beydoun, 2007).