School of Public Health

Ethnic and Cultural Influences on Body Composition, Lifestyle and Body Image among Males

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

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Abstract

The aim of this research was to determine ethnic and cultural influences on body composition, lifestyle, and aspects of body image (perception, acceptability, and satisfaction) of younger (age 18-40 years) Australian and Japanese males, the latter including groups living in Australia and Japan. The sample sizes of the three groups were 68 Japanese living in Australia, 84 Japanese living in Japan, and 72 Australian Caucasian males respectively.

The methodology included body composition assessments (by anthropometry and DXA), lifestyle and body image questionnaires, and dietary records. The study found significant (*p*<0.05) ethnic differences in the %BF at given BMI levels and for Japanese the BMI values of 23.6kg/m^2 and 28.6kg/m^2 were found to be equivalent to 25 and 30 for Caucasians when used to classify individuals as “overweight” and “obese”. Equations in common use for the calculation of body composition in Japanese males were evaluated using modern methods of body composition assessment and found to need considerable modification. New regression equations that represent BMI-%BF relationships for Japanese and Australians were proposed:
Japanese: Log %BF = -1.330 + 1.896(log BMI), (R^2 = 0.547, SEE = 0.09);
Australians: Log %BF = -1.522 + 2.001(log BMI), (R^2 = 0.544, SEE = 0.10).

Equations were also developed to predict %BF for Japanese and Australian males from body composition assessments using anthropometry and DXA:
Japanese: %BF = 0.376 + 0.402(abdominal) + 0.772(medial calf) + 0.217(age), (R^2 = 0.786, SEE = 2.69);
Australians: %BF = 2.184 + 0.392(medial calf) + 0.678(supraspinale) + 0.467(triceps), (R^2 = 0.864, SEE = 2.37).

Lifestyle factors were found to influence perceptions of body image. Australian males participate in physical activity more frequently than their Japanese counterparts (Australians = 98.6% involved in vigorous activity at least once per week, Japanese living in Japan = 85.7%, Japanese living in Australia = 72.1%). Significant differences (*p*<0.05) in energy contribution patterns were found between the Japanese group (Protein: 14.4%, Carbohydrate: 50.4%, Fat: 28.1%) and Japanese living in Australia (JA: Protein: 16.3%, Carbohydrate: 47.3%, Fat: 32.3%) and the Australians (Protein: 17.1%, Carbohydrate: 47.9%, Fat: 30.6%). This shows that the Japanese living in Australia have adopted a more westernised diet than those living in Japan.

Body Image assessments were done on all study groups using the Somatomorphic Matrix (SM) computer program and questionnaires, including the Ben-Tovim Walker Body Attitudes Questionnaires, (BAQ) the Attention to the Body Shape Scale (ABS), and the Eating Attitudes Test (EAT). Japanese males tended to overestimate their weight and amount of body fat, while Australian Caucasian males underestimated these parameters. The Japanese groups had higher scores on the self-disparagement subscale and lower scores on the strengths and the attractiveness subscales of the BAQ questionnaire than Australian males. Australian males also had higher scores on the EAT total score and the dieting subscale of the EAT questionnaire than Japanese males. When all groups of subjects selected their perceived body image from the SM program menu, these results had no relationship with measured body composition values, suggesting that further development of this program is needed for use in these populations.

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Chapter 1 - Introduction

1.1 Background

The issue of overweight and obesity has become a serious public health concern throughout the world during last few decades. The prevalence of obesity ranges from 10–25% in most Western countries, but this rate increases in specific populations, for example, African-American women (up to 40%) and Samoans living in the Polynesian islands (up to 70%) (WHO 1997a; WHO/IASO/IOTF 2000). Overweight and obesity are associated with many factors including diet, physical inactivity, ethnicity, socioeconomic status, and genetic factors. The fundamental problem that leads to this condition is the imbalance between energy intake and energy output (WHO 1997b).

At the opposite end of the spectrum, the incidence of eating disorders such as anorexia nervosa (AN) and bulimia nervosa (BN) is generally low in Western populations (Davis & Yager 1992). However the incidence rates of these problems, and the risk of associated unhealthy behaviours, can be high among subgroups of the population, such as adolescent females, gymnasts, and marathon runners. Eating disorders have been estimated as the third most common chronic health problem among teenage girls, following obesity and asthma (Touyz, Russel & Beumont 1996). As with obesity, the causes of eating disorders are multi-factorial, but body dissatisfaction has been identified as one of the triggers for the onset of the disorder (Levine & Piran 2004).

To date, researchers commonly discussed the problems of obesity and eating disorders separately. However, both problems are related to the concept known as "body image". In general terms, body image refers to any image associated with the human body. Every individual has their own body image by which they judge and adjust their appearance throughout their lifetime. Problems may arise when an individual's body image fails to maintain normal functioning and leads them into unhealthy behaviours. An abnormal body image is also known as "distorted body image".

The topic of body image has been studied in a number of scientific disciplines, including neurology, psychology, psychiatry, epidemiology, and more recently, in public health. Since the term "body image" was proposed by Paul Schilder in 1950, it has been used across a wide range of academic fields. As a result, its definition has become broad and often vague, which may lead to confusion. In this thesis the value of the concept of "body image" will be discussed from a public health perspective.

Several studies have suggested that a relatively large proportion of the population may hold a distorted body image (Cash 1990; Bunnell et al. 1992). Individuals with a distorted body image are often preoccupied with their visual appearance and are likely to engage in unhealthy behaviours such as dieting (Serdula et al. 1993) and the use of drugs (Blouin & Goldfield 1995). In contrast those who are overly optimistic about their body may have little motivation to maintain their health and can increase the risk of becoming overweight and obese. A failure to maintain a body image that accurately reflects one's current physique may lead to a development of various health problems. Unnecessary dieting may increase the risk of growth failure among adolescents, as well as the future development of chronic health problems such as coronary heart disease and stroke (Kagawa 2000). These consequences are similar to those stemming from obesity, for example, an increased risk of type II diabetes mellitus, hypertension, stroke, cardiovascular diseases, and various forms of cancer (Stevens et al. 1998; Matsuzawa et al. 2000).

The maintenance of a healthy body image may therefore be important in the prevention of the development of a number of health problems. Despite the evidence about the importance of body image in determining individual behaviour, such as excessive dieting, it has been uncommon to include an assessment of body image perception in public health nutrition research studies. The majority of body image studies have been conducted from a psychological standpoint and have generally focused on the links between eating disorders, and other mental problems. Further, many have only used self-administered questionnaires and have not linked this information with physical and objective data, such as body composition, dietary intake and physical activity levels.

1.2 Statement of significance

This study reports comprehensive anthropometric data, such as body size, shape, and percent body fat (%BF), for Japanese living in different countries, together with data of other ethnic groups. In comparison with previous studies that only compared data obtained from separate studies using different methodologies, the current study uses standardised methodology and could be expected to have greater validity. The application of comprehensive anthropometry allowed the examination of ethnic differences in the BMI-%BF relationship and appropriate BMI cut-off points for overweight and obesity.

The significance of the study is in the identification of specific ethnic groups with substantially distorted body images, as well as environmental variables that could lead to a development of health problems. The specification of a risk group may allow for the development of prevention strategies for that group, in order to increase their awareness and progress towards a healthy body image and lifestyle. In the long-term, the proposal of prevention strategies may be beneficial for public health, as it could reduce the number of 'at-risk individuals' whose health conditions are a potential financial burden to the community.

This study focused on males rather than females. This is because research on males' body image, especially in a cross-ethnic setting, is extremely limited. The incidence of eating disorders and other related problems is increasing among males (Braun et al. 1999). At the same time, overweight and obesity among males is high in many developed countries, including countries of the Far East such as Japan and South Korea (Moon et al. 2002; Yoshiike et al. 2002). However, due to a lack of previous studies, ethnic differences in the risks of developing eating disorders and obesity among males in relation to their body image and body composition have seldom been reported in the literature.

The most significant feature of the current study is the inclusion of Japanese males living in a foreign country. The number of Japanese living in foreign countries is increasing (MOFA 2002). Epidemiological studies of migrant populations have made major contributions to the understanding of environmental influences on chronic disease aetiology. Research on the risks of cancer and diabetes in relation to lifestyle and body composition frequently uses Japanese subjects living overseas, including those of Japanese descent (eg, Japanese-Americans and Japanese-Brazilians) (Huang et al. 1996). There have only been a limited number of studies that compare differences in body composition, together with body image and lifestyle variables, of Japanese males and other ethnic groups. There have been no reported studies that have compared the impact of living environment upon boy composition and body image, on Japanese males living at home compared to those living abroad. With changes in lifestyle, such as nutrient intake and exercise levels, actual body composition can change and it could be expected that this will have an impact on body image formation. Because of this gap in current knowledge, it is important to examine how changes in environment and lifestyles impact on body composition and body image.

1.3 Aim

To determine the impact of ethnicity and environmental variables on body composition, and body image and on the risk of developing an eating disorder or becoming overweight or obese, using the following groups of subjects:

1) Japanese males living in Japan (JJ),
2) Japanese males living in Australia (JA), and
3) Australian Caucasian males living in Australia (AA)

1.4 Objectives

1. To document ethnic differences in body composition, including %BF and sum of skinfolds and to relate this to body mass index (BMI).
2. To determine the impact of living in various countries upon body composition.
3. To examine the ethnic and cultural difference in lifestyle variables, such as eating behaviours, nutrient intake and level of physical activity.
4. To identify differences in body perception in relation to measured body composition between Japanese and Australian Caucasian males.

5. To assess the relationships between body image, lifestyle variables and the risk of developing health problems across the study groups.
6. To examine the validity of ‘the Somatomorphic Matrix’ (SM) computer-based body image assessment program for Japanese and Australian males.
7. To examine the validity of translated questionnaires, namely the Ben-Tovim Walker Body Attitude Questionnaire (BAQ), and the Body Shape Scale (ABS), to Japanese males.

1.5 Hypotheses

1) H_O: There is no difference in body composition, such as %BF, and its relationship with the BMI across males of different ethnic backgrounds.
2) H_O: Aspects of lifestyle such as dietary behaviour and physical activity do not differ across ethnic background and country of residence.
3) H_O: There is no difference in the subjective body image possessed by males of different ethnic backgrounds.
4) H_O: There is no difference in body perception and satisfaction in relation to one’s own body composition regardless of ethnicity and a country of residence.
5) H_O: There is no difference in body image responses and the risks of developing health problems across ethnicity and a country of residence.
6) H_O: the body image assessment instrument ‘the Somatomorphic Matrix’ is applicable for multiple ethnic populations.
7) H_O: Japanese-translated questionnaires have validities equivalent to the original questionnaires.

In order to assess the aim of the current study, several issues required clarification. These were:

1) the identification of appropriate body composition prediction equations for Japanese males living in Australia;
2) the identification of BMI cut-off points for Japanese males living in Australia; and
3) the validation of an existing body image assessment instrument, known as ‘the Somatomorphic Matrix’ (SM).

These steps were important in order to obtain valid and reliable study results. The absence of studies examining the above-listed issues also highlights the importance of the current study.

1.6 Abbreviations used in the thesis

%BF	Percent Body Fat
AA	Australian Caucasian males living in Australia
ABS	Attention to Body Shape Scale
AMA	Arm Muscle Area
AN	Anorexia Nervosa
ANNS	Australian National Nutrition Survey
BAQ	Ben-Tovim Walker Body Attitude Questionnaire
BD	Body Density
BIA	Bioelectrical Impedance Analysis
BID	Body Image Distortion
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BN	Bulimia Nervosa
cAMA	Corrected Arm Muscle Area
Ca	Arm Circumference
CM	Estimated Muscle Arm Circumference
D	Weight of the skin and subcutaneous adipose tissue
DPA	Dual Photon Absorptiometry
DSM	Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association
DXA	Dual energy X-ray Absorptiometry
DW	Density of Water
EAT	Eating Attitudes Test
ED	Eating Disorders
EDI	Eating Disorders Inventory
EDNOS	Eating Disorders Not Otherwise Specified
FFM	Fat-Free Mass
FFMI	Fat-Free Mass Index

FM	Fat Mass
IASO	International Association for the Study of Obesity
ICC	Intraclass Correlation Coefficient
IOTF	International Obesity Task Force
ISAK	International Society for the Advancement of Kinanthropometry
JA	Japanese males living in Australia
JJ	Japanese males living in Japan
JASSO	Japan Society for the Study of Obesity
JNNS	Japanese National Nutrition Survey
M	Weight of the skeletal muscle
MAC	Mid-Arm Circumference
MB	Mass of the Body
MBA	Mass of the Body in Air
MBW	Mass of the Body in Water
MJ	Ministry of Justice
MOFA	Ministry of Foreign Affaires of Japan
NIR	Near Infrared Interactance
O	Weight of the skeleton
R	Weight of the remainder
RDA	Recommended Dietary Allowance
RV	Residual Volume
S	Triceps Skinfolds
SEE	Standard Error of Estimate
SL-ASIA	Suinn-Lew Asian Self-Identity Acculturation Scale
SM	Somatomorphic Matrix computer program
TEM	Technical Error of Measurement
W	Human gross weight
WHO	World Health Organization
WHR	Waist-to-Hip Ratio

1.7 Definition of terms used in the thesis

Adiposity: The total amount of adipose tissue present in the body, that is, the subcutaneous adipose tissue, the internal adipose tissue surrounding the organs, viscera and skeletal muscles.

Anthropometry: A system of human measurement used to assess gross structure and function.

Australian Caucasian: The group of population who are 1) of Australian residents, 2) both parents are "Caucasian" ie, not of a mixed parentage, and 3) recognised themselves as of "Caucasian" origin ie, not as "Asian", "Hispanic", or "Black".

Body acceptability: The range of visual preference of the human body that can be identified as "acceptable" (ie, not as "too thin" or "too fat"). The range could vary between gender, ethnicity and degree of preoccupation toward thinness.

Body image: Any image regarding with the human body, which may be of spatial existence, of motion that the body causes, or of visual shape and size, or of composition, either as a whole or as parts, that constructs and alters throughout the lifetime. The formation of image is based on, either alone or in combination of, one's biological and psychological mechanisms, lifetime experience, and knowledge gained from any potential influential variables.

Body Mass Index (BMI): Weight (kg)/Stature^2 (m); a body size index used to assess a level of fatness.

Body perception: The person's perception of physical, visual appearance of his or her body, either as a whole or as parts of body. It is categorised by his or her own standard that is constructed by experiences and knowledge obtained throughout his or her lifetime.

Body satisfaction: The degree of satisfaction towards one's own physical size, shape, and compositions, either as a whole or as each body part, regardless of degree of accurate recognition toward his or her true physical body structure.

Criterion: A standard of which used to judge or evaluate issues of the interest. In this thesis, the term refers to Level four anthropometrist, an anthropometrist who appointed by ISAK for his or her long experience in taking measurements, a high level of theoretical knowledge, has been involved in several large anthropometric projects and has a publication record in anthropometry (Gore et al. 1996).

Distorted body image: The condition where the person's perceptions about own body (eg, body mass, fatness, and muscularity) are substantially different from the measured values obtained from detailed body composition assessment methods.

Eating Disorders: Disorders which are listed and defined in the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM®). Namely, Anorexia Nervosa (AN), Bulimia Nervosa (BN), Eating Disorders Not Otherwise Specified (EDNOS), and Binge Eating Disorder.

Fat: Ether extractable lipid which consists of adipose tissue and what are termed the essential lipids, the structural phospholipids of cell membranes and nervous tissues, lipids of bone marrow, and a small amount of other lipid based compounds.

Fat mass (FM): The ether extractable lipid which assumed to have a constant density of $0.907 g.cm^{-3}$ at 36 degrees C (Withers et al. 1996).

Fat-free mass (FFM): The mass of remaining body tissues after ether extraction of all lipid, which includes lipids of adipose tissue, bone, nervous tissue and structural lipids from membranes (Drinkwater, 1984).

Japanese: Individuals who are 1) born in Japan, 2) have Japanese nationality, 3) speak Japanese as their first language, and 4) both parents are Japanese.

Kinanthropometry: An emerging scientific specialisation that employs measurements to appraise human size, shape, proportion, composition, maturation, and gross function, in order to determine growth, nutritional status, sports performance and a risk to develop chronic health problems, including obesity and diabetes mellitus (Ross & Marfell-Jones 1991).

Landmarks: The anatomical landmarks on the skeleton that identify the exact location of the measurement site.

Lean body mass: The whole body other than the adipose tissue.

Masked obesity: A condition of excess total body fat deposition of individuals, whose body mass and the BMI are within the "average" or even "underweight" categories. Individuals with masked obesity are often visually thin and difficult to detect their obesity from their visual appearance (Kajioka et al. 1996a).

Obesity: A condition of excess total body fat deposition. In this thesis, males with %BF of 20 and above were classified as obese (Nagamine 1972).

Waist-to-Hip Ratio (WHR): The ratio of the waist measurement to the hip measurement; a method for assessing fat distribution.

Chapter 2 - Review of Literature

This section of the thesis will explore past reported studies that have determined topics of anthropometry, lifestyle, and body image and how they are inter-related. In addition, studies that examined body composition and body image in cross-ethnic, cross-cultural settings were reviewed. This literature review particularly concentrate studies that used Japanese subjects.

Part I. Anthropometry

2.1 Definitions of Anthropometry and Kinanthropometry

Anthropometry is the systematic collection of and correlation of measurements of the human body (Encyclopadia_Britannica 2004). Anthropometry has been used to assess gross structure and function, including body size, shape, proportion, and body composition. Because assessment of the human body is important to determine its relationship with a risk of health problems such as overweight, growth failure, and eating disorders, anthropometry is an important technique in the field of public health and nutrition.

Any scientific research that includes assessment of the human body is considered as "kinanthropometric" research. The term "kinanthropometry" has been defined as:

"An emerging scientific specialisation that employs measurements to appraise human size, shape, proportion, composition, maturation, and gross function"

(Ross & Marfell-Jones 1991).

Assessment of the human body to solve the problems in relation to the human growth, body performance, and all other issues associated with nutrition is important. Therefore kinanthropometry may be considered as a fundamental discipline in human research.

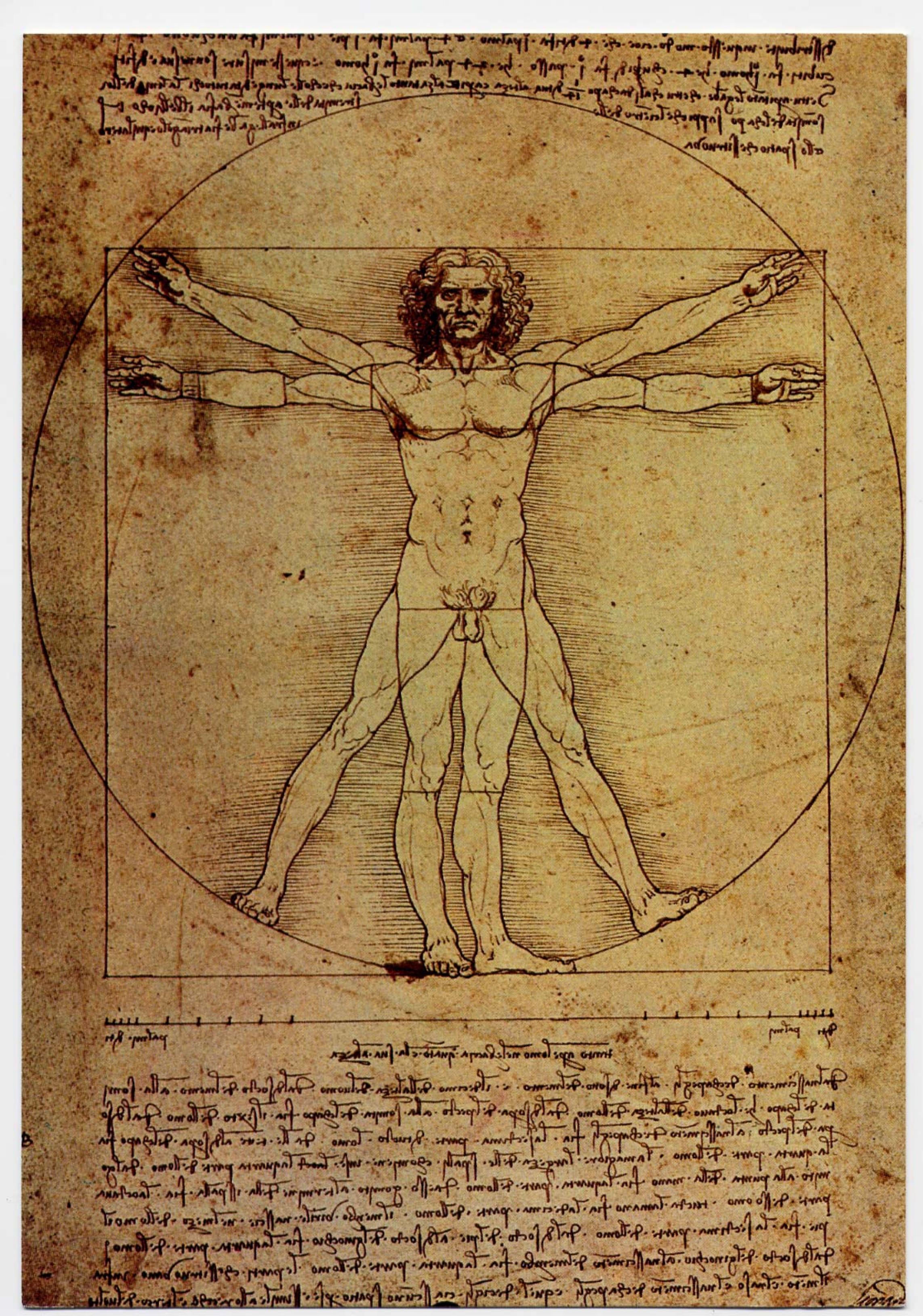
2.2 Anthropometry in the Pre-Modern era

Interest in the study of the composition of the human body can be traced back to the ancient Greek period of Hippocrates (460-375BC). He proposed a theory in his treatise *On the Nature of Man*, that the human body consists of four elements: blood, phlegm, yellow bile and black bile. He believed that in order to maintain health a balanced proportion of these elements that form the human body needed to be maintained (Galen 1998). His theory reflects a fundamental concept of Hermetism, a major field of science of the period, which derived from knowledge available in Alexandria, Egypt and alchemy of the Greeks (Fabricius 1976). Under the influence of Hermetism, he assumed that the four elements were closely associated with the four characteristics of dry, wet, hot and cold – an imbalance of which lead to a development of disease (Galen 1998).

During the same era, the Greek philosophers wrote about the "Golden mean", which was defined as the human physique with perfect body proportion and beautiful visual appearance (Fallon 1990).

During the Renaissance era there was a renewed interest in body shape and proportion, particularly among artists of the period. Artists such as Leon Battista Alberti (1405-1472) and Leonard da Vinci (1452-1519) dissected, measured and sketched human bodies to bring realism into their artworks. They also tried to discover the "Golden mean" of the human body. One of the classical examples of the "Golden mean" is the "Vitruvian man", drawn by Leonardo da Vinci (Figure 2.1).

Figure 2.1 The “Vitruvian man” drawn by Leonardo da Vinci



2.3 The development of body composition assessment methods

In the modern era, Brozek and Prokopec (2001) stated that Jindrich Matiegka, the Czech anthropologist, first introduced the term anthropometry in 1921. Matiegka's system subdivided the gross body weight (W) of humans into four components:

- weight of the skeleton (O),
- weight of the skin and subcutaneous adipose tissue (D),
- weight of skeletal muscle (M), and
- the remainder (R)

Hence, gross body weight was calculated from the following equation:

$$W = O + D + M + R$$

His concept was the first scientific fractionation procedure of the human body, "fractionation" being defined as a partitioning of total body mass into different compartments (Olds et al. 1996). The concept of subdividing the body into several compartments has become a fundamental part of body composition assessment today.

The major and basic form of fractionation is known as the two-compartment model, which divides human beings into fat mass (FM) and fat-free mass (FFM). After the development of new technologies, complex compartment models, namely the three- and the four-compartment models, were developed. These compartment models subdivide human beings into not only FM and FFM but also into total body water, bone mass and residual mass (Withers et al. 1996). Assessment of these components can be achieved by the use of advanced body composition assessment methods such as dual energy x-ray absorptiometry and nuclear magnetic resonance.

Body composition assessment method have been classified into three levels by Martin and Drinkwater: (Martin & Drinkwater 1991).

(1) Direct

(2) Indirect, and

(3) Doubly indirect

Body composition assessment methods that correspond to each level of these levels are shown in Appendix One.

2.4 Direct method

In anthropometry, the direct method of body composition assessment refers to cadaver analysis which can be examined by either anatomical or chemical methods. Chemically, the human body is assessed in terms of the amount of water, fat, protein and various minerals in different tissues (Clarys, Martin & Drinkwater 1984). The anatomical analysis examines the cadaver by dissection of the body into readily separable components such as skin, muscle, adipose tissue, bone, and organs. Chemical analysis was made from only eight cadavers until the Brussels cadaver study (Clarys, Martin & Drinkwater 1984), which used an anatomical approach and added considerable new knowledge of human body composition. They reported complete data from the dissection and anthropometric measurement of a 25 cadavers of elderly Belgium people. As this is the only method in anthropometry which allows the direct measurement of adipose tissues mass, it has been used to test the validity of body compartment models, such as two-compartment model. Information from cadaver analysis also used to evaluate results obtained from other body composition assessment methods including skinfold techniques (Clarys et al. 1987), Waist-to-Hip Ratio (WHR) (Martin et al. 2003), and methods of advance technology (eg, CT scan and DXA) (Mitsiopoulos et al. 1998).

2.5 Indirect methods

Indirect methods are also known as level two methods. They are “indirect” because body composition can only be assessed by accepting a series of assumptions. Indirect methods include hydrodensitometry, measurement of total body water by doubly labelled water, total body potassium, and duel energy x-ray absorptiometry. These methods are based on the two-compartment model, which differentiates the human body into FM and FFM in order to determine body density and body composition.

2.5.1 Assumptions of Indirect Methods

Each indirect method has its own sets of assumptions in order to determine FM and FFM. The FM and FFM assumptions for indirect methods are as follows (Withers et al. 1996);

Hydrodensitometry:

FM has a density of 0.9007g.cm^{-3} at 36°C

FFM has a density of 1.1000g.cm^{-3} at 36°C

Total body water:

FM is anhydrous

FFM has 72% body water

Total body potassium:

FM contains no potassium

FFM has a potassium concentration of 68.1mmol.kg^{-1}

According to Clarys, et al. (1984), the basic concept of these assumptions is a constant density of FFM. However, these assumptions are not applicable to the entire population. The density of FFM varies depending on subjects' age, gender, hydration status, and the amount of muscle they have.

2.5.2 Dual energy x-ray absorptiometry (DXA)

Dual energy x-ray absorptiometry (DXA) uses two x-ray beams of different energies simultaneously and differentiates the body into total body mineral, mineral-free lean, and fat tissue masses (Heyward 1998). DXA is an advanced form of dual photon absorptiometry (DPA) and was originally developed to assess bone mineral content (Peppler & Mazess 1981; Lukaski 1987). A major change from DPA is that DXA replaced the gamma rays with x-rays, which enabled a reduction of radiation exposure for subjects (Prentice 1995). The exposure from a whole-body scan ranges from 0.05mrem to 1.5mrem. The exposure from DXA is less than from DPA (10 to 15mrem) or from conventional x-rays used for other medical purposes (25-270mrem)

(Lohman 1996). From the values reported by the National Council on Radiation Protection and Measurement in 1987, radiation exposure from DXA is also much smaller than many forms of naturally occurring radiation (ie, background radiation), such as cosmic rays (27mrem/year), internal radioactive nuclides (39mrem/year), and consumer products (10mrem/year) (Tipler & Llewellyn 1999). In addition, DXA has reduced the time of assessment to less than five minutes, thus reducing the burden on the subjects (Taaffe 1992; Jebb & Elia 1993; Heyward 1998). The measurement of body composition using DXA shows sufficient level of correlation and consistency with other level two methods, such as underwater weighing and bioelectrical impedance method for it to have become the most commonly used method in research (Wang et al. 1989; Heymsfield et al. 1990; Svendsen et al. 1991; Loan & Mayclin 1992; Johansson et al. 1993; Wellens et al. 1994; Tothill et al. 1998; Van Loan 1998).

Wellens, et al. (1994) compared the body composition of 128 white adults (78 women, 50 men aged 18-67 years old) obtained from DXA, underwater weighing, and the total body water method. The results showed a close agreement in predicted %BF and FFM values obtained from the DXA and underwater weighing methods. The standard error of estimates (SEEs) of the predicted %BF between DXA and underwater weighing are 2.3% ($r = 0.86$) in men and 3.2% ($r = 0.90$) in women. Among the methods examined, the total body water method showed the highest variability. Furthermore, Jebb and Elia (1993) suggested that DXA has an advantage over underwater weighing, total body potassium and the water dilution methods in that it can provide information about the composition of each limb and of the trunk separately.

2.5.2.i) Assumptions and limitations of DXA

As with other body composition assessment methods, the software algorithms used in DXA calculations rely on a number of assumptions:

- Lean body mass contains 73.2% water
- The head contains 17.0% fat

(Taaffe 1992)

Lohman (1996) has stated following assumptions:

- The hydration state of lean body mass is 0.73ml/g
- Consistency of anteroposterior thickness of the body
- The composition data obtained is related to the area of the body analysed

(Lohman 1996)

Roubenoff, et al. (1993) suggested that a hydration status of subject has an impact on DXA result. However, Lohman (1996) and Heyward (1998) suggested that fluctuation of body water has minimal impact on the measurement if the variation is within 1-3% of body weight. With regards to anteroposterior thickness, Lohman (1996) summarised from his review that anteroposterior thicknesses between 20 and 25cm may have significant effects on the estimates of fat and bone. Nonetheless, DXA has a high sensitivity and is minimally influenced by thickness if it was less than 20cm. For the third assumption, it has been estimated that 40 to 45% of the 21,000 pixels in a typical whole-body scan contain bone in addition to soft tissue, and that these pixels are therefore excluded from the calculation of values for soft tissues. Consequently, if the excluded pixels contained a considerable amount of soft tissues, systematic error will result. Individual variation between two regions may be another source of error in estimating total body composition. Hence DXA assumes that the composition of each body region is equally represented, per unit volume, in the calculated total body values (Lohman 1996).

Variables considered in assumptions for DXA analysis, especially of the water and fat contents of lean body mass and the head may vary according to the age and gender of the subjects. Although the reproducibility of the measurements of fat is within 1% difference for adults, Jebb and Elia (1993) suggested in their review that absolute accuracy of DXA has not yet been clarified as there is very little data comparing absolute measurements to chemical analysis of cadavers.

While DXA has shown its ability to be used as a body composition assessment instrument of relative validity, several considerations remain with respect to its applicability. DXA equipment has been manufactured by three major companies: Hologic®, Lunar® and Norland®. These companies use different databases and software for analysis, which leads to difficulties in comparing data obtained from different DXA machines (Jebb & Elia 1993; Lohman 1996; Heyward 1998; Kistorp & Svendsen 1998). From the analytical review, Fogelholm and Lichtenbelt (1997) suggested that the difference in results obtained from DXA and underwater weighing is largely depend on the manufacturer and the version of the software. There is also a problem in the size of the scanning area, which is approximately 190 x 60 cm. If the subject has a stature above two metres or has a wide physique, the scanning region is exceeded and leads to measurement error (Jebb & Elia 1993). In addition the accuracy of body composition estimation may be reduced in subjects above 100kg in weight (Lohman 1996). Furthermore, even though the radiation dose from DXA is low, it cannot be used safely in pregnant women and should be used with caution in women of childbearing age (Lohman 1996).

2.6 Doubly indirect methods

Doubly indirect methods are also known as level three methods in anthropometry. These methods are called “doubly indirect” because they use equations that were developed from the level two methods, which were derived under certain sets of assumptions. Simple anthropometry, such as skinfolds and girth measurements, and impedance analysis methods are classified under this category. From anthropometry, various anthropometry indices such as the body mass index (BMI) and the waist-to-hip ratio (WHR) can be calculated.

2.6.1 Anthropometry (Skinfolds)

The skinfold method is one of the most popular techniques for predicting body fat. Because of its non-invasive nature and portability, it can be used in both clinical and field settings.

As well as the assumptions for the level two methods, level three methods also possess their own assumptions. The assumptions for skinfold technique are as follows:

1) The thickness of subcutaneous adipose tissue reflects a constant proportion of the total body fat.
2) The site selected for measurement represents the average thickness of the subcutaneous adipose tissue.

(Lukaski 1987)

In addition to the above assumptions stated by Lukaski (1987), Heyward (1998) has added the following assumptions:

1) Skinfold is a good measure of subcutaneous fat;
2) The distribution of fat subcutaneously and internally is similar for all individuals;
3) The sum of several skinfolds can be used to estimate total body fat;
4) There is a relationship between the sum of skinfolds and BD;
5) Age is an independent predictor of BD for both men and women;

These assumptions do not always hold in practice due to variability in the relationship between skinfolds and BD. Also a relationship between visceral and subcutaneous adipose tissues, which can be measured by skinfold method, is not constant across every individual. These relationships vary depending on the subject's age, gender and ethnicity.

In addition, variation in compressibility of skinfold and skin thickness of measurement sites affect the reproducibility and validity of the measurement (Clarys, Martin & Drinkwater 1984; Clarys et al. 1987). The Brussels cadaver study showed that compressibility of skinfolds and also skin thickness were different, depending on measuring sites (Clarys, Martin & Drinkwater 1984). Hence it is possible that, although obtained skinfold values were comparable, the actual subcutaneous fat values may differ. The validity of the measurement also decline if the subject has a large amount of subcutaneous fat deposition. Further, a precision of the technique relies much upon the skill and experience of anthropometrist who obtained the data, and the prediction equations used to determine body composition of study population (Wagner & Heyward 1999).

While acknowledging the above assumptions, the skinfold technique, some individual skinfolds and sum of skinfolds show a strong correlation (r) with %BF, ranging from 0.7 to 0.9 (Roche 1996). From the Brussels cadaver study, Martin, et al. (1985) also suggested a high correlation between internal and subcutaneous fat regardless of gender ($r = 0.75$ for males, $r = 0.89$ for females). The use of a prediction equation that incorporates by the sum of skinfolds and girths measurements together, can further increase a level of correlation with %BF (Roche 1996).

2.6.2 Anthropometry (Girth, bone breadths)

Girths or circumference measurements, such as of upper-arm girth (Mid Upper Arm Circumference or MUAC) have been commonly used in the assessment of protein-energy malnutrition (Brodie, Moscrip & Hutcheon 1998). Estimated muscle arm girth can be used as an indicator of the muscle mass of the entire body and hence of the size of the body's main protein reserve (Lukaski 1987). The equation used to estimate muscle arm circumference is:

$$Cm = Ca - \pi * S$$

Where:

Cm = Estimated muscle arm circumference in cm

Ca = Arm circumference (maximum) in cm

S = Triceps skinfold in cm

(Lukaski 1987)

The cross-sectional fat and muscle areas are relatively stable among young children before their growth spurt, particularly in children 1-5 years, and can be used to determine their protein-energy malnutrition status. The study by Gurney and Jelliffe (1973) proposed an equation to predict the upper arm muscle cross-sectional area, which is also called as arm muscle area (AMA):

$$AMA = (Ca - \pi * S)^2 / 4 * \pi$$

Where:

AMA = Arm muscle area

Ca = Arm circumference (maximum) in cm

S = Triceps skinfold in cm

(Gurney & Jelliffe 1973)

The above equations are based on assumptions which are listed below:

(1) The mid-arm is circular.
(2) The triceps skinfold is twice the average fat rim diameter.
(3) The mid-arm muscle compartment is circular.
(4) Bone atrophies in proportion to muscle in cases of protein-energy malnutrition.

(Lukaski 1987)

Heymsflield, et al. (1982) stated that the AMA prediction equation greatly overestimates (range 15-25%) when compared with the results obtained for arm muscle area using the CT scan. From a study using 26 healthy and 67 undernourished subjects (including both genders) aged between 20-70 years old comparing anthropometry with CT scan results, they proposed gender-specific equations that reduced the average error for a given subject to 7-8% for the AMA estimation:

Male: $cAMA = [(MAC - \pi * S)^2 / 4 * \pi] - 10$

Female: $cAMA = [(MAC - \pi * S)^2 / 4 * \pi] - 6.5$

Where:

cAMA = Corrected arm muscle area

MAC = Mid-arm circumference

S = Triceps skinfold

(Heymsfield et al. 1982)

Their study, however, did not state the actual number of male and female subjects included in each study group. Hence the validity of the results of this study remains uncertain. In addition, while AMA only determines muscle area, it is important to recognise that assessment of both fat and muscle areas provide a better indication of nutritional status.

In addition to skinfolds and girths measurements, bone widths and lengths measurements are also a part of anthropometry. The measurement of bone is based on the hypothesis made by Behnke that measurement of bone diameters can be used to estimate skeletal mass and thus FFM (Lukaski 1987). At the same time, few studies have examined the relationship between frame size and body fatness (Baecke, Burema & Deurenberg 1982; Rookus et al. 1985; Fehily, Butland & Yarnell 1990). However, it has been concluded that breadth measurement has a low correlation with %BF (Roche 1996). Girth and bone breadth measurements only measure the diameter of limbs and trunk or the bone size. Thus it is always essential to combine girth and bone breadth measurements with skinfolds in order to predict the body composition of a region or the entire body.

To date, a range of protocols for anthropometry, that includes skinfolds, girths, and bone breadths measurements, have been developed (Behnke & Wilmore 1974; WHO 1995; Norton et al. 1996). In order to reduce estimation errors, it is important to standardise measurement methods. Such standardisation also allows comparison of results that obtained across studies. The protocol that has recently acknowledged as the international standard is the ISAK protocol, which was proposed by the International Society for the Advancement of Kinanthropometry (ISAK) (ISAK 2001).

2.6.3 Bioelectrical impedance analysis (BIA)

Bioelectrical impedance analysis (BIA) is a body composition assessment method based on a difference in the conductivities of FFM and FM. FFM, such as blood and muscle tissues, contain electrolytes and water hence is more conductive than FM. In the BIA theory, FM includes adipose tissue and bone tissue. Both adipose and bone tissues have little water and conductive electrolytes thus represent a low conductive, high electrical resistant pathway (Anderson 2003). With additional information on body mass, stature, gender and age, BIA can be used to estimate individuals' total body water using the appropriate regression equation. Using the total body water value, FFM can be estimated and because FM is assumed to be anhydrous, estimation of FFM is possible (Heyward 1998). The BIA device is quick, easy, non-invasive, portable and inexpensive.

Compared with densitometry, Lukaski (1987) reported that BIA has a FFM prediction error of 2.7%. Several studies have compared the results obtained from BIA with that obtained from level two methods (Jackson et al. 1988; Pritchard et al. 1993). Jackson, et al. (1988) compared values obtained from BIA with anthropometry and hydrostatic method using 44 women and 24 men. Generalisability analysis of variance model showed very high reliability for both genders, correlations ranged from 0.97 to 0.99. Using an additional 38 women (n = 82) and 26 men (n = 50), it's the validity of BIA for measuring %BF was compared to results obtained from using the hydrostatic method. The results obtained from BIA showed correlations ranged from 0.71-0.76, which was lower than the results obtained from sum of seven skinfolds (r = 0.92-0.88). Pritchard, et al. (1993) compared the results obtained from BIA with the results from DXA manufactured by two different companies (ie, Hologic® and Lunar®). The results showed high correlations with DXA of both manufacturers (r = 0.79 for Hologic®, r = 0.82 for Lunar®).

While BIA showed relatively high correlations with level two methods, it is important to recognise that BIA is based on the following assumptions:

(1) The human body is shaped like a perfect cylinder with a uniform length and cross-sectional area.
(2) Assuming the body is a perfect cylinder, at a fixed signal frequency the impedance to current to flow through the body is directly related to the length of the conductor and inversely related to its cross-sectional area.
(3) Biological tissues act as conductors or insulators, and the flow of current through the body will follow the path of least resistance.
(4) Impedance is a function of resistance and reactance.

(Heyward 1998)

In addition to the above assumptions another source of error is the intra-individual variability in whole-body resistance due to factors that affect the subjects' level of hydration and temperature (Baumgartner 1996; Heyward 1998). From the review, Heyward (1998) suggested that measurement two to four hours after a meal can overestimate FFM by 1.5kg and dehydration may cause underestimation of FFM. In addition, exercise lead to an increased electrolyte concentration in the body fluid and increased skin temperature. These changes cause a decline in resistance to the current flow, which result in overestimation of FFM. To avoid large intra-individual variability, measurement under controlled settings is therefore important.

Although the BIA method is technically applicable to all subjects regardless of gender, age, ethnicity, and health status (Baumgartner 1996), application to neonatal and severe obese individuals may be less accurate than its application to general individuals. This is because of the shorter distance between electrodes and the effect of thick subcutaneous adipose tissue. In addition, BIA also requires a population specific prediction equation that is appropriate for each study group (Kushner 1992; Baumgartner 1996).

2.6.4 Anthropometric indices (the Body Mass Index (BMI)/ the Waist-to-Hip Ratio (WHR))

Anthropometric indices such as the BMI and the WHR have been frequently used world wide to assess the level of fatness and fat distribution of individuals. These indices are simple, easy, quick, and most importantly, they have strong correlations with a number of health problems such as obesity, cardiovascular diseases and diabetes.

The body mass index (BMI) is based on the Quetelet index, the equation established by Adolphe Quetelet (1796-1874), the Belgium astronomer, philosopher, anthropologist, and mathematician. It can be calculated from the equation:

$$\text{BMI} = \text{weight (kg)} / \text{height (m)}^2$$

An increase in the BMI above 25 increases the risk of developing various health problems, including type II diabetes and coronary heart diseases (Garrow 1999; Matsuzawa et al. 2000). Stevens, et al. (1998) conducted a 12 year longitudinal study in the US using a sample of 62,116 men and 262,019 women aged above 30 years old at the baseline. The results of this study showed that a high BMI is associated with high mortality from all causes of deaths and also from cardiovascular diseases up to 75 years of age (Stevens et al. 1998). A Japanese study (Matsuzawa et al. 2000) reported the odds ratios of developing health problems among 634 subjects (442 males and 192 females, mean age 57 ± 10 years) with their BMI ranged 26.4-30 and 25-26.4 were 3.9 and 2.5 respectively. Similarly, an epidemiological study was conducted in Shanghai using a randomly selected sample of 2,776 adults (1,106 males and 1,670 females) age ranged between 20 and 94 years old (Jia et al. 2002). The study reported that the prevalence of diabetes, impaired glucose regulation and metabolic syndromes increased progressively as the BMI increased above 23kg/m^2.

The World Health Organization (WHO) has developed a universal classification of health conditions using the BMI values (WHO 1997a). Cut-off points for each category are:

Class III under-nutrition:	BMI 16.0
Class II under-nutrition:	BMI 17.0
Class I under-nutrition:	BMI 18.5 >
Normal range:	BMI 18.5 - 24.9
Pre-obese:	BMI 25 - 29.9
Class I obese:	BMI 30 - 34.9
Class II obese:	BMI 35 - 39.9
Class III obese:	BMI 40

The BMI has been used frequently as an indication of health status, but there are limitations that need to be considered. According to Garn, et al. (1986), the major limitations of the BMI are:

(1) BMI may be stature dependent,
(2) BMI may be affected by relative leg length or relative sitting height, and

(3) The use of weight as the numerator suggests that the BMI may reflect both lean and fat tissues to a comparable degree.

These findings are supported by other researchers (Norgan & Ferro-Luzzi 1982; Ross et al. 1988; Heyward 1998; Wang et al. 1994) who also concluded that the BMI is a proportion between stature and body mass and cannot distinguish FM and FFM of individuals. From the findings, it can be stated that the BMI can be large if an individual has a long trunk and short legs, regardless of the actual amount of fat deposition. As trunk and leg lengths vary with age, gender and ethnicity, using the BMI for the assessment of body composition can lead to prediction error in body composition. Hence, the use of population-specific cut-off points, rather than single universal cut-off points, may be required (Gallagher et al. 1996; Schaefer et al. 1998; Deurenberg, Deurenberg-Yap & Guricci 2002). A new cut-off point has been proposed specifically for the population of the Asia-Pacific region by the WHO (WHO/IASO/IOTF 2000). Considering the variation in the relationship between the BMI values and health risk across ethnic groups, the WHO expert consultation recently proposed new recommendations which includes statement about higher health risks for specified populations, including those living in the Asia-Pacific region (WHO 2004). Because of a wide variability of cut-off points reported from previous research the WHO decided to retain their current classification as the international standard. However, to make it an effective screening tool for health problems, they proposed to add BMI cut-off points of 23, 27.5, 32.5, and 37.5kg/m^2 as cut-off points for public health action.

Therefore, although the BMI is useful indicator of health risk at the population level, it cannot be used for the prediction of specific body composition parameters, such as %BF. This is particularly important if applying the BMI to individuals. To obtain detailed body composition information on individuals additional body composition assessment methods are needed to supplement the calculation of the BMI.

Waist-to-hip ratio (WHR) is another anthropometric index, which has been used frequently for health assessments. It is calculated from the waist and gluteal (hip) girth measurements:

WHR = Waist circumference (cm)/Gluteal circumference (cm)

It has been suggested as being useful for distinguishing types of adipose tissue distribution patterns or obesity within human beings. There are four major types of obesity:

Type I	Excessive fat distributed across all body regions
Type II	Excessive fat in the abdominal region ie, "Android"
Type III	Excessive deep abdominal fat
Type IV	Excessive fat in the gluteal and femoral regions ie, "Gynoid"

(Bouchard 1991)

Android body type is a consequence of large adipose tissue deposits within the abdominal region. As this type of obesity has a higher risk of internal adipose deposition around the organs, as well as external deposition as subcutaneous fat, a greater risk of cardiovascular diseases is present in comparison with gynoid body type. When the WHR is used, android gives higher WHR values than gynoid. The WHO has developed gender-specific cut-off points for increased health risks (0.91-1.00 for male, 0.80-0.91 for female).

Similar to the BMI, the WHR can be used as an indicator of health risk. In Australia, two recent epidemiological studies by Dalton, et al. (n = 11,247, subjects aged 25 years and above) (2003) and Welborn, et al. (n = 9,206, subjects aged 20-69 years) (2003) showed that the WHR is strongly correlated with cardiovascular disease risk factors.

While acknowledging its usefulness as a health risk indicator, particularly at the population level, one limitation of the WHR is again, its inability to differentiate specific body composition parameters. For all of the above reasons it is recommended that detailed anthropometry such as skinfolds and girths measurements should be combined with simple indices described above when assessing individuals.

2.7 Development of prediction equations

In the field of anthropometry a number of prediction equations have been developed. The most common prediction equations are those for body density (BD) and percent body fat (%BF). Prediction equations are usually developed from multiple regression analyses using the data obtained from studies using highest level of body composition data that is available.

Body density prediction equations can be developed from data obtained using level two (indirect) body composition assessment methods such as underwater weighing in the laboratory setting. Using underwater weighing, the BD of the subject can be calculated using the equation below:

$$BD = MBA/([MB - MBW/DW] - RV)$$

Where:

BD = Body density
MBA = Mass of the body in air (g)
MB = Mass of the body (g)
MBW = Mass of the body in water (g)
DW = Density of water
RV = Residual volume

(Norton 1996)

The assessment of body density using underwater weighing is based on Archimedes' principle. That is, a volume of water equivalent to the volume of the body will be displaced when the body is immersed in water. From the underwater weight the body density can be readily determined.

Body density obtained from underwater weighing is the standard for assessing body composition using level three methods including anthropometry and BIA. Many body density prediction equations have been developed using body density obtained from underwater weighing and variables obtained from anthropometry, BIA, and ultrasound. Underwater weighing is often inconvenient and equipment is not available, especially in studies collecting data at the field setting. Therefore development of body density prediction equations using underwater weighing results is important as application of these equations allows prediction of body density from the results obtained from the field methods.

When anthropometry results are used in a development of body density prediction equations, the following assumptions about skinfold techniques must be considered:

1) Constant compressibility of the skinfolds
2) Skin thickness being negligible or a constant fraction of the skinfolds
3) Fixed adipose tissue patterning
4) Constant fat fractionation of the adipose tissue
5) A fixed proportion of internal to external fat

(Norton 1996)

These assumptions are not always true for every individual. Differences occur due to biological differences between subjects and also by the measurer's skill (technical error). In addition, compressibility may vary depending on the type of skinfold caliper and calliper jaw pressure used in the measurement.

The number of %BF prediction equations developed from other body composition methods such as DXA and ultrasound in combination with underwater weighing or anthropometry (Abe & Fukunaga 1995) is increasing. However, many reported studies still determine body composition of study groups by calculating body density and then converting the obtained body density into %BF values.

Several prediction equations have been developed to convert body density into %BF including the equations developed by Lohman, Brozek, et al., or Siri (Shephard 1991). Such conversions are possible because previous research using cadaver analysis has provided data on the densities and relative proportions of the chemical components of the various body tissues (Norton 1996).

Body composition values, such as body density and composition of FFM, vary with individuals' age, gender, and physical activity levels. When applying body density prediction equations, a specific equation which was developed from a study group with similar characteristics must be used in the calculations. That is, most equations used in body composition assessments are “population-specific”.

Also converting BD into %BF using any prediction equation may lead to an error. This is a consequence of inter-individual variability of body density and composition of FFM, which is known as “biological error”. The assumptions associated with biological errors are:

1) Densities of FM and FFM are constant
2) Individual components of FM and FFM have constant densities
3) Proportional contributions of FFM components are invariant

(Norton 1996)

Estimation of %BF using both body density and body fat prediction equations is almost always associated with prediction error. To minimise error, it is recommended to use the minimum number of prediction equations as possible. In anthropometry, it is best to use data that was directly obtained by body measurement (eg, sum of skinfolds and girths).

Assessment of body composition is important to determine health status of specific study groups, including the risk of nutritional deficiency, growth failure, or the risk of being overweight or obese. There are a number of different body composition assessing methods available and it is important to apply the appropriate method for the study with consideration of limitations and assumptions of the method. Many body composition assessments use prediction equations to determine body density or %BF of the study group. However, it is important to acknowledge that prediction equations are “population-specific” and application of prediction equations is almost always associated with errors as a consequence of inter-individual variability of the human body composition.

Part II. Body image

Body image is one topic that has been frequently discussed in psychology and some medial disciplines, including psychiatry and neurology. Consequently the topic of body image has been mainly discussed in relation to mental and psychological problems, including depression and unusual eating behaviours that could lead to eating disorders. It has rarely been examined in relation to physical health problems such as overweight or obesity. In addition, there are a limited number of reported studies that combined body image assessment with detailed body composition assessment to determine a discrepancy between perceived and the actual body composition of individuals. This section of the literature review presents historical aspect of body image, followed by potentially associated health problems for having incorrect body image and summarising types of instruments that has been used in body image research.

2.8 History

The first detailed reports of cases of distorted perception of one's own body among brain-damaged or injured patients were published as early as the 16th century by neurologists (Shontz 1990). These patients' symptoms included the denial of the existence of body parts, an inability to distinguish the right and left side of the body, a refusal to acknowledge the incapacitation of the paralysed body regions, and even attributing new or supernumerary body parts to themselves (Fisher 1990). Patients with "phantom-limb" syndrome showed an inability to recognise the absence or presence of a body part. They were thought to have damage in the parietal lobes of the brain (Cumming 1988).

Since the misidentification of own body parts was reported, several neurologists have attempted to explain the association between brain function and this problem. In 1905, Bonnier proposed the "schema" model (Shontz 1990). "Schema" is a psychological term defined as:
"The mental representation of a concept; the information stored in long-term memory that allows a person to identify a group of different events or items as members of the same category." (Gray 1991)

Bonnier proposed that "schema" has a topographical organisation and imparts a spatial quality to the perception of stimuli on the body (Shontz 1990). Later this theory was revised that individuals construct an image of their body in space and use this image as a standard for judging current bodily stimulations (Shontz 1990).

In 1926, Henry Head, who was a British investigator and neurologist, first introduced the term "body schema". He proposed that overall neuronal activity serves as a guide in the localisation of body stimuli and in steering postural and movement adjustments (Fisher 1990; Shontz 1990). According to Head's theory, "body schema" has an unconscious influence over the body, although it also affects conscious experiences such as body movements. Head made an attempt to explain normal body experience rather than pathological body image, which was the major focus of the time. However, early studies on body schema were mostly based on the brain physiology or the "organic" perspective with little emphasis on personality and psychological aspects (Fisher 1990). Consequently, the proposed theories were too narrow to explain the entire concept of body image.

Paul Schilder, a neurologist, first introduced the term "body image" in 1950 in his text *The Image and Appearance of the Human Body* (Schilder 1950). He proposed the need to analyse body distortion not only in relation to brain physiology but also in relation to psychological aspects (Fisher 1990). His analysis of body image unified the organic and psychological aspects as well as sociological viewpoints (Fisher 1990).

2.9 Definition of "Body Image"

Schilder defined body image as:

"The image of the human body means the picture of our own body which we form in our mind, that is to say, the way in which the body appears to ourselves. There are sensations which are given to us. We see parts of the body surface. We have tactile, thermal, pain impressions. There are sensations which come from the muscles and their sheaths – and sensations innervation of the muscles – and sensations from the viscera. Beyond that there is the immediate experience that there is a unity of the body. This unity is perceived, yet it is more than a perception. We call it a schema of our body or bodily schema – following Head, who emphasizes the importance of the knowledge of the position of the body, postural model of the body. The body schema is the tri-dimensional image everybody has about himself. We may call it "body image"" (Schilder 1950, p11)

As discussed by Bruch in 1974, Schilder's body image concept is constructed from the integration of both sensory and psychic experiences via the central nervous system. His body image concept addresses how individuals could identify and develop their real body image, that is, the identification of their own body physique. However, it is important to acknowledge that his meaning of "body physique" does not include body composition but body parts that are visually recognisable, such as limbs. His distinction between 'body physique' and 'body size' is most likely due to the fact Schilder developed his concept through observation of his neurological patients, who were unable to identify body parts. As a result, the definition of his "distorted body image" was limited to the inability to identify one's body parts and does not include the misperception of body size, shape, or body composition. Nevertheless, his concept is important for understanding the mechanism by which human beings integrate sensory information and physical information to construct basic models of their own bodies.

Various researchers, predominantly psychologists, have focused on the body image topic and proposed their definitions of body image. In 1988, Slade defined body image as:

"The picture we have in our mind of the size, shape and form of our bodies; and to our feelings concerning the size, shape and form of our bodies, and its constituent parts." (Slade 1988, p20)

Later he suggested that body image consists of two major components; the "perceptual component" and the "attitudinal component" (Slade 1994). Slade's body image concept incorporates several aspects of body image, including 1) the accuracy of body size estimation (or of body perception), and 2) the attitudes or feelings toward one's own body (Slade 1994).

Myers Jr. and Biocca (1992) hypothesised four components that are required to construct one's body image:

a) a socially represented ideal body,
b) the internalised ideal body,
c) the present body image, and
d) objective body shape

However, they failed to provide a clear definition of the term "body image" itself. They defined body image as one aspect of "self-schema" and no further explanation was provided. In addition, they stated that body image is a mental construction rather than an objective evaluation (Myers Jr. & Biocca 1992). This statement reflects the incompleteness of their concept of body image. Objective evaluation of one's own physique can be done by sensory or visual functions and therefore the objective evaluation is important in the formation of a person's body image. The importance of objective evaluation of one's body image was proven by the improvement of body image in the presence of a mirror (Norris 1984; Gardner et al. 1989).

Recently O'Dea (1995) has reviewed many available studies and summarised the description of "body image" as:
"…a concept or scheme incorporating a collection of feelings and perceptions such as overall awareness of the body, perception of body boundaries, attention to parts of the body as well as the whole, perception of size of parts and the whole, position in space and gender-related perceptions." (O'Dea 1995)

In O'Dea's review on body image, and as suggested by Bruch (1974), it is clear that the concept of "body image" is complex and difficult to define. While a few researchers have stated the conceptual differences that they have used (Cumming 1988; Shontz 1990), there is no consistent definition of "body image" that is clearly distinguishable from other terms of similar meaning such as "body schema", "body experience", "body concept" and "body percept" (Cumming 1988; Sims 1988; Fisher 1990). In other words, the term "body image" has been independently used by each researcher, without having a clear standard definition.

In relation to this complex and ambiguous use of body image terminologies, Shontz (1990) has proposed a comprehensive theory that subdivides body image into four levels (Table 2.1).

Table 2.1 Levels and their functions in the comprehensive model

LEVELS	FUNCTIONS
Body schemata	Body serves as a sensory register and information processor
Body self	Body serves as a stimulus to self Body is used as an instrument for purposive action Body serves as source of biological needs, drives, reflexes, and instincts
Body fantasy	Body serves as a stimulus to others Body serves as an expressive instrument
Body concept	Body is known cognitively as an abstract entity Body experience constitutes a private world

(Adopted from Shontz, 1990)

His theory is important as it suggests that the identification of the body could occur at different levels of consciousness. He hypothesised that a neural recognition of one's own body (body schemata) is a different level of body image from justification of one's own body by looking at a mirror based on knowledge they have (body concept).

In addition to the abovementioned terminologies, terms like "body (dis)satisfaction" and "body perception" are also frequently used in body image studies. "Body (dis)satisfaction" is one aspect of body self because satisfaction and dissatisfaction are based on past experiences and impressions. By contrast, "body perception" is one aspect of "body concept" because perceptions such as "fat" or "thin" are justified by their knowledge. Hence, although these terms may be associated with each other, it is important to acknowledge that these are aspects of body image happening at different levels of consciousness.

From this current review of past research, no single definition of body image is complete in itself. By acknowledging that the body image can be constructed at various levels of consciousness, the following definition for the term "body image" will be used in this study.

"Any image of the human body, which may be of spatial existence, of motion that the body causes, or of visual shape and size, or of composition, either as a whole or as parts, that constructs and alters throughout the lifetime. The formation of image is based on, either alone or in combination of, one's biological and psychological mechanisms, lifetime experience, and knowledge gained from any potential influential variables."

This definition incorporates most of the important concepts of previously proposed definition of "body image".

2.10 Factors associated with body image formation

Schilder (1950) claimed that body image is based upon interaction with other people as well as one's emotional state. Sims (1988) cited a statement by Bahnson that body image develops via psychological development, through growth, which allowed the differentiation and identification of the "self" from the surrounding environment. Regardless of their views development of the concept of body image, both researchers suggested a flexibility of body image in relation to one's development.

In 1992, Myers Jr. and Biocca proposed an "elastic body image" theory, which is based on the interaction between the flexibility of body image and the influence of social cues (1992). In comparison with previous definitions, the "elastic body image" theory placed more emphasis on the interaction of social cues, particularly of the media, to one's body image formation. However they failed to provide a clear definition of "body image" and considered a role of objective evaluation in the body image construction as minor. The "elastic body image" theory with its emphasis on the influence of variables that surround individuals has been supported by an number of authors and studies (Norris 1984; Gardner et al. 1989; Haimovitz, Lansky & O'Reilly 1993; Touyz et al. 1994; Pinhas et al. 1999; Springer et al. 1999). These studies reported a change or improvement in body dissatisfaction and symptoms of eating disorders by being exposed to influencing variables, such as mirrors, the media and video-tapes of their own eating behaviours.

In the formation of body image Slade (1994) has suggested that a number of factors are influential.

1) History of sensory input to body experience,
2) History of weight change/fluctuation,
3) Cultural and social norms,
4) Individual attitudes to weight and shape,
5) Cognitive and affective variables,
6) Individual psychopathology, and
7) Biological variables

These factors can be categorised into four groups:

1) Environmental,
2) Personal,
3) Biological/Psychological maturation, and
4) Cultural

Factors corresponding to each category are listed in Appendix Two with studies that are examined in relation to each of the factors. The roles of some of these factors await confirmation by further research.

2.11 "Distorted" body image and its gender differences

As the body image is an important part of self-recognition, it would be ideal to form a body image that closely reflects the person's current body. However, some individuals may establish a body image that incorrectly reflects their actual body and which can sometimes lead to harmful behaviours. These incorrect images are referred to as "distorted body image".

The concept of body image distortion was first proposed by Higgins (1987). He defined various domains of "self" (actual, ideal, ought) and "standpoints" for which "self" was perceived ie, own and others. From these definitions he outlined possible variations of body image distortions which he included in his "self-discrepancy theory" (1987).

More recently, Thompson, et al. (1995) defined distorted body image as:
"Any form of affective, cognitive, behavioral, or perceptual disturbance that is directly concerned with an aspect of physical appearance." (Thompson et al. 1995)

Distorted body image is a prominent feature of several health problems, such as eating disorders (ED). The presence of body image distortion has been confirmed in several studies on eating disordered patients (Slade & Russel 1973; Abraham et al. 1983; Norris 1984; Willmuth et al. 1985; Bell, Kirkpatrick & Rinn 1986; Whitehouse, Freeman & Annandale 1988; Horne, Van Vactor & Emerson 1991; Nelson & Gidycz 1993; Gila, Castro & Toro 1998). It is important to realise that a number of studies have reported the presence of body image distortion among non-clinical subjects (Bunnell et al. 1992; Parks & Read 1997).

2.11.1 "Distorted" body image among females

Across a range of studies conducted by different researchers, females expressed dissatisfaction toward their current body and almost always wished to become thinner (Garner et al. 1980; Birtchnell, Dolan & Lacey 1987; Gruber et al. 2001). Cash (1990) reported that a considerable proportion of normal weight females overestimate their own weight. Several factors are thought to have an influence on body dissatisfaction and distorted body image in females. These include biological maturation, and influence of the menstrual cycle (Altabe & Thompson 1990; Carr-Nangle et al. 1994), and the development of gender role identity that every adolescent experiences (Usmiani & Daniluk 1997).

As females pass through puberty they will undergo increased adipose tissue deposition. At the same time, they develop a gender role identity. The higher risk of developing distorted body image, dissatisfaction, and over-concern toward their own bodies among adolescent females could be due to a gap between the ideal female images possessed by the society they live in and their biological increase of adipose tissue mass that occurs with puberty.

Studies have shown that the menstrual cycle can affect the formation of body image in females. In 1990, Altabe and Thompson examined relationships between menstrual cycle, body image, and eating disturbances using 60 undergraduate females aged between 17 and 25 at the University of South Florida. Body image was assessed by the Adjustable Light Beam Apparatus method and questionnaires included the Drive for Thinness and Body Dissatisfaction subscales of the Eating Disorder Inventory, and the Physical Appearance Evaluation subscale of the Body Self-Relations Questionnaire. In addition, the Menstrual Distress Questionnaire was administered in order to obtain information on menstrual symptomatology. The result showed greater body image distortions and eating disturbances during the perimenstrual phase. Similarly, a study by Carr-Nangle, et al. (1994) using 26 healthy females (mean age 32.3 years old) in the US indicated high negative body image thoughts during the perimenstrual phase.

2.11.2 "Distorted" body image among males

In comparison to females there has been a lesser number of studies that focused on the body image of males (Dolan, Birtchnell & Lacey 1987; Drewnowski & Yee 1987; Blouin & Goldfield 1995; Pope Jr et al. 2000; Cohane & Pope Jr 2001). Unlike females, males who expressed dissatisfaction tend to split into two subgroups, those wish to lose weight and others who wish to gain weight and to become "bigger" (Drewnowski & Yee 1987; Silberstein et al. 1988; Paxton et al. 1991). This is different from what is seen in females, a majority of whom wished to become thinner. O'Dea (1995) has stated that males who wished weight gain are most likely to be groups who are underweight or perceived themselves as underweight.

As mentioned above, a certain proportion of males wished to be "bigger" and a recent review by Labre (2002) summarised that the male ideal body image is becoming more muscular. However the majority of studies conducted on males have failed to identify if the boys' preferred "bigness" is due to increase of muscle mass or fat mass (Cohane & Pope Jr 2001). This may be because only a limited number of body image studies that incorporated an assessment of body image with detailed body composition assessment of subjects to determine their ideal body image and an accuracy of their perceptions toward own body have been done on males. Adolescent males in particular, are thought to be at risk of experiencing body dissatisfaction and force themselves into unhealthy weight-control behaviours, or excessive muscle-gaining behaviours. Because of a limited number of studies, the accuracy of males' body perception in relation to their actual body composition remains relatively unknown. Consequently, the need for these weight-control behaviours for a health or fitness purpose is unknown.

While Philips, et al. (1995) suggested that either obsessional or delusional thinking by the subject is one cause of body image distortion, the exact causes and the mechanisms of body image distortion are not yet clear. One of the reasons is that many studies have treated the issue of body image as only one of the number of factors that may contribute to the development of eating disorders. Consequently, there have been few studies that have focused on body image by itself, particularly of males. One of the reasons for fewer studies on males compared to females is due to the higher prevalence of eating disorders among females rather than males, even though the prevalence of eating disorders among males is showing an increasing trend (Braun et al. 1999).

2.12 Body image: A causative factor in health problems

It has been suggested that body image distortion is a consequence of neural or brain dysfunctions, and also because of problems in psychological interruption (Pruzinski 1990; Shontz 1990). The distorted body image developed from the above possible causes is then thought to have associated with a number of problems that interferes healthy lifestyle.

According to Pruzinsky (1990), psychological problems can be subdivided into:

1) Disorders in which body image problems are a central defining feature (eg, body dysmorphic disorder, gender identity disorders), and
2) Disorders in which body image is an associated, but not the primary cause of the problem (eg, sexual dysfunction, schizophrenia).

From a clinical perspective, Slade has subdivided body image problems into three categories:

1. Neurological disorders
2. Body dysmorphobia or body dysmorphic disorders, and
3. Body image distortion

(Slade 1994)

Relatively large proportions of the general public possess a certain degree of distorted body image. Among those, some have body image related concerns, such as “fat phobia” and “muscle dysmorphia”. These problems could lead to the development of more serious health problems.

2.12.1 Fat phobia

Fat phobia is defined as “an intense fear of becoming obese” (Rieger et al. 2001). A large proportion of females is fearful of gaining weight and become overweight and obese. Even though their weight is within the “average” range, those individuals with over-concern for their own weight and fatness are more likely to participate in some form of dieting and restrained eating behaviours. Such unnecessary concern and eating behaviour may accelerate a preoccupation towards their bodies and cause further distortion of body image. These factors are also risk factors which can develop more harmful health problems such as eating disorders.

2.12.2 Muscle dysmorphia

The term “muscle dysmorphia” was proposed by Pope Jr., et al. (1997), as a novel form of body dysmorphic disorder. It is specifically prevalent among males and it has been described as a preoccupation with the appearance and muscularity of one’s own body. Muscle dysmorphia was previously known as “reverse anorexia”. It was so called because it showed similar symptoms observed from patients of anorexia nervosa (AN). In muscle dysmorphia however, the individual’s focus is on muscularity rather than weight or fatness. It is important to recognise that such desire to become bigger may have a potential health risk for individuals to exercise excessively or engage in dieting behaviours. Pope Jr. and colleagues (1993; 1997) also suggested that individuals with muscle dysmorphia have a potential risk for a drug abuse, which drugs include anabolic steroids.

2.13 BID-related Health problems – Nutrition perspectives

Previous researchers have reported that distorted body image does impact on eating behaviours (Cattarin & Thompson 1994; O'Dea 1995; French et al. 1997). A concern toward one's own body may lead to dieting behaviours such as fasting, restraining, and not eating breakfast. Even though not all individuals on diets are at risk, individuals with severe concern towards their own body may develop eating behaviours that are similar to eating-disordered patients, including vomiting and use of diuretics.

In this section previous studies that examined a relationship between body image and different forms of eating behaviours (ie, dieting, restrained eating, and eating disorders) were reported. Suggested health problems that could be derived from continuation of these behaviours are development of disordered eating, risk of growth failure, and increased risk of becoming obesity and cardiovascular diseases.

2.13.1 Dieting

Dieting, such as calorie restriction, fasting and skipping meals, is a common method of weight control. In comparison with males who use exercise as their major weight-control method, a large proportion of females use dieting as their weight-control method (Abraham et al. 1983; Crawford & Worsley 1988; Moore 1993; Serdula et al. 1993; Patton et al. 1997).

Serdula, et al. (1993) studied the prevalence of various weight-loss behaviours among US high school students from grade nine through to grade twelve (n = 11,467), and among adults aged 18 and above (n = 60,861). The study was conducted by a self-report questionnaire for students and a telephone survey was conducted for adults. They found that 44% of female students and 15% of male students were attempting to lose weight at the time of the survey. In adults, 38% of women and 24% of men reported that they were trying to lose weight. Not eating meals at least once a day was more common in female students than in males (49% females, 18% males). Welch, et al. (1992) conducted a study on 106 university students (69% females) who attended a university wellness program in the US. Among these subjects, 40% of them reported missing breakfast at least five times per week.

While dieting and not eating meals are frequently reported among adolescent females, not all females who expressed a desire for thinness are overweight or obese. Patton, et al. (1997) conducted a study of 2,525 teenagers living in Australia in order to determine the prevalence of dieting. Subjects were in year 7 (479 males, 477 females), year 9 (437 males, 474 females), and year 11 (301 males, 357 females). Assessment was conducted by computer-based self-administered questionnaires. The subjects were classified into four subgroups; "extreme", "intermediate", "minimal", and "none" dieters, based on the score obtained from the Adolescent Dieting Scale. The majority of dieters (51% of intermediate dieters and 58% of extreme dieters) were within a "normal" or even "low" BMI range. From the study, Patton, et al. (1997) reported that dieting is more common among teenage girls. They suggested various reasons for dieting by those of "normal" weight category. Reasons include the desire to have a better appearance and peer pressure. Edlund, et al. (1999) conducted a study on 122 Swedish girls aged 8 and 16 years old using questionnaire and body composition assessments. The results showed that dieting girls were fatter than non-dieting peers but their BMI was within a normal range and hence could not be considered as overweight.

These studies revealed a high prevalence of unnecessary food restrictions among adolescent females, who require an adequate amount of nutrients for the growth and development of their muscles and bones. Turner, et al. (2001) conducted a study in Western Australia on 69 female patients who had been diagnosed as eating disordered to determine contributing factors for their low bone density. They conducted interviews, blood sampling and body composition and bone density measurements using DXA. From the results, they suggested that people with lower bone density are those who have dieted for longer periods.

Such unnecessary dieting behaviours may not only reduce bone mineral density but may paradoxically increased risk of increasing their weight and blood cholesterol levels when they finished dieting, which may increase a risk of developing nutrition-related health problems in adulthood such as coronary heart diseases (Kagawa 2000). A combination of increasing physical activity level and controlling energy intake is important to maintain energy balance and is the recommended method of weight-control. However many females tend to lose their body mass only through dieing. Weight-control only through dieting (ie, the restriction of food intake) may have an effect on body composition, such as a loss of muscle mass rather than just the loss of fat mass. Kajioka et al. (2002) reported that females who have lost weight increased the ratio of fat mass (FM) to lean body mass (LBM). However, they used only a very small sample size (n = 5) of female Japanese college students to reach their conclusions. Consequently a strong statement on the effect of dieting upon body composition cannot be made from this study alone. Further research will be required to provide a definitive answer to this question using a larger sample size.

Gruber, et al. (2001), examined the relative roles of body fat, body perception and body ideals as motivations for dieting in 45 dieting and 32 non-dieting college females. From the results they suggested that distorted body image perception may play a large role in the motivation of females to diet. Their statement is consistent with the suggestion made by Edlund, et al. (1999) that a discrepancy between current and ideal body shape in combination with higher body fat may be important factor in the initiation of dieting. While all dieters do not necessary develop eating disorders, a review by Striegel-Moore, et al. (1986) indicated that dieting may be a contributing factor in eating disorders. Groups of people who have engaged in repeated dieting are likely to be most vulnerable to the development of eating disorders (Striegel-Moore, Silberstein & Rodin 1986). This is because repeat dieters have higher risk of regaining weight. This increase in body weight may force them to commence alternative methods of dieting, such as purging.

2.13.2 Restrained eating

Restrained eating is also considered to be a form of dieting. It is defined as a person's tendency to eat less than biologically needed. Restrained eaters are those who are consciously aware of constantly monitoring their food intake (Gorman & Allison 1995). The main concept underlying restrained eating is the "set point" theory, which was introduced by Nisbett in 1972 (Herman & Mack 1975; Herman & Polivy 1975; Gorman & Allison 1995). According to Nisbett's model, a "set point" is a biologically determined point possessed by individuals, which regulates their body weight. As a consequence, people with high set points have a higher possibility of being overweight and obese. Herman and Mack (1975) extended Nisbett's theory. They hypothesised that a large proportion of the 'normal' weight population is in fact biologically "underweight", but restrain their food intake to maintain an "ideal" weight (Herman & Mack 1975). They examined the eating behaviours of 45 female university students in order to assess the hypothesis that highly restrained eaters will eat more food than less restrained eaters once their biological demand overcomes their regulation of food intake. The study showed an increased consumption of food in high restraint subjects after the preload than after no preload at all. In comparison, low restraint subjects consumed lower amount of food as a function of the size of the preload (Herman & Mack 1975). The findings supported the hypothesis that high restrained eaters were those who were biologically "underweight" but regulate their food intake to maintain socially acceptable weight.

Several studies have investigated body image in restrained eaters. Wardle and Foley (1989) examined body size estimation, body satisfaction, and feelings of fatness before and after two meals, using 20 females aged 18 and 24 years. The two meals had equivalent caloric values but were different in appearance; one looked like "fattening" food, the other like "slimming" food. Restrained eaters perceived themselves as being fatter and the group of 'high restrainers' had lower levels of satisfaction than the 'low restrainers'. The study also found increased feelings of fatness among the low-restrained group after eating the "fattening" meals.

Nelson and Gidycz (1993) examined body image distortion using the Figure Rating Scale. The subjects were 57 bulimic, restrained and normal women (n = 19 of each category). The instrument has nine drawings of both genders and use drawings of different appearance. The subjects were asked to choose one of nine figures which ranged from "very thin" to "very heavy" to represent their current appearance, their ideal figure, and the figure they believed was most attractive to men. The study reached two conclusions;

1) The mean difference between current appearance and ideal figures selected by restrained eaters was not significantly different in bulimic and normal subjects, and

2) Both the bulimic and the restrained subjects rated their current figure larger than what they believed men would find most attractive, in comparison with normal subjects.

3) In normal subjects the discrepancy between their current figure type and the figure type which they believed men would find attractive were narrower than bulimic and restrained subjects.

Meijboom, et al. (1999) studied the relationship between self-esteem, body shape and weight concerns in 53 women with restrained eating (26 high level restrained eaters, 27 low level restrained eaters). Over-concern with body shape and weight, as well as low self-esteem was found in the high level restrained eaters (Meijboom et al. 1999). The study also suggested a more severely distorted body image among restrained eaters than non-restrained eaters.

Restrained eating is often associated with a high level of preoccupation with, and over-concern towards, one's own body. Restrained eaters may be under a condition where they could develop further preoccupation toward their own bodies and consequently lead to practices that are similar to eating disordered patients. In addition, severe restrained eating may also lead to overeating once an individual loses control over their eating (Gorman & Allison 1995). This extreme possibility is then associated with a risk of becoming overweight and obese. Further, O'Dea (1995) suggested that eating restraint in childhood and adolescence not only increases the risk of developing eating disorders, but also affects an individual's growth and development.

2.13.3 Eating Disorders (ED)

2.13.3.i) History

Avoidance of eating has been reported as early as ancient Egypt and Babylon. The phenomenon was variously explained as fasting, the possession of evil spirits, the result of miracles and as a means of earning money by showing themselves as not eating any food for a long period (Kimura 1998; Kiriike 2000). The recognition of such phenomena as medical conditions, and the introduction of terms given to symptoms similar to those of eating-disordered patients today, first occurred during the 17th Century (Kimura 1998). The condition of anorexia nervosa was first mentioned as “phthisis nervosa”, or “nervous consumption” by Richard Morton in 1689 and published in English as *Phthisiologia: or, a Treatise of Consumptions* five years later (Bruch 1974; Kimura 1998; Kiriike 2000). Later the condition was given the term “anorexia nervosa” by Gull in 1874 (Bruch 1974; Kimura 1998; Nishizono 1999). Gull explored the syndrome in 1868 and named it as “Anorexia Nervosa (apepsia hysterica)” at the Clinical Society of London in 1874. In 1888 Gull published a clinical report on a 14 year old girl who showed a severe loss of weight and emaciation after displaying repugnance towards food (Gull 1888). Almost simultaneously, Lasegue, a French doctor, named this symptom “hysterical anorexy” in 1873 (Janet 1929). In the 19th Century, there was thought to be a strong association between the symptoms of anorexia nervosa and hysteria.

Janet (1929) discussed the cause of the disorder in relation to hysteria. Janet suggested that:

> “Refusal of food is not always a phenomenon of the hysterical neurosis; they belong at least as often to the psychasthenic neurosis.” (Janet 1929, p. 235)

Stunkard (1993) cites the origin of the term “bulimia” as a combination of the ancient Greek terms “limos”, meaning “hunger”, and either of the terms “bou-” or “boul-”, meaning “a great amount of” and “ox (or steer)” respectively. He suggests that the term may have been used as early as the 8th Century BC. The term “boulimie” was first introduced by Blanchez in a medical encyclopaedia published in Paris in 1869 (Nogami & Satou 1998).

Until recently, bulimia nervosa had been perceived as a warning symptom of anorexia nervosa (Russel 1979; Fairburn & Wilson 1993). Such a perception is a consequence of the similar psychopathology and symptoms which patients of both disorders possess. Russel (1979) stated that bulimia nervosa might be viewed as an aftermath or chronic phase of anorexia nervosa. However, Russel himself viewed bulimia as a different disorder from anorexia and devised a set of criteria to diagnose a patient as bulimic.

2.13.3.ii) Classifications of eating disorders

Among a range of classification methods (Kimura 1998; WHO 2000), the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM®) is the most widely accepted classification of eating disorders. The fourth edition (DSM-IV®) is the most recent and currently its text-revised edition (DSM-IV®-TR) is available (APA 2000) There are three major categories of "eating disorders" in DSM-IV®: anorexia nervosa (AN), bulimia nervosa (BN), and eating disorders not otherwise specified (EDNOS) (APA 2000). Definitions of each category are listed in Appendix Three.

2.13.3.iii) Physical and social problems resulting from ED

As a consequence of frequent vomiting, eating-disordered patients show several signs of physical damage; for example, the erosion of enamel teeth due to acid and the swelling of salivary glands. As well as delaying of menarche in females, eating-disordered individuals can also develop a number of complications. Patients can develop osteoporosis and anaemia from their inadequate nutrient intakes. Together with reduced nutrient intakes, electrolyte imbalances from induced vomiting may cause problems such as arrhythmia, low blood pressure and alkalosis (Bruch 1974; Russel 1979; Kitamura et al. 1985; Inoue et al. 1986; Takagi 1998; Nishizono 1999). In serious cases, death can be a consequence. Eating disordered patients not only suffer physically, but can also develop other mental and behavioural problems. These include absenteeism from school, suicide attempts, shoplifting, domestic violence and even murder (Takagi 1998; Kitamura 1994; Kitamura 1999). It has also been suggested that eating-disordered patients, in particular bulimic individuals, often suffer alcohol or drug abuse (Suzuki et al. 1994; Wilkinson 2000). Those individuals with alcohol/drug abuse problems are at greater risk of developing the above listed problems (Suzuki et al. 1994).

2.13.3.iv) Prevalence and mortality of ED

In the 19th Century and early years of the 20th Century, Gull (1888) and Janet (1929) reported cases of eating-disordered patients. Janet observed that there was a group with a high risk of developing eating disorders and identified them as following:

"The greatest number of cases by far —nine out of ten— is to be met within girls of sixteen to twenty-three or twenty-five at most." (Janet 1929, p229)

Recently several epidemiological studies have been conducted to determine incidence, prevalence, and mortality rates of eating disorders (Crisp, Palmer & Kalucy 1976; Schwartz, Thompson & Johnson 1982; Patton 1988; Ben-Tovim & Morton 1990; Lucas et al. 1991; Crisp et al. 1992; Davis & Yager 1992; Eckert et al. 1995; Sullivan 1995; Inaba 1996; Keel & Mitchell 1997; Hay & Fairburn 1998). Details of selected Western studies are listed in Appendix Four.

In addition, there are several reviews of the incidence and prevalence rate of eating disordered patients (Davis & Yager 1992; Kiriike 2000). Davis and Yager (1992) summarised the incidence of anorexia nervosa among the general population in Western countries which ranged from 0.37 to 1.6 per 100,000 people per year. Kiriike (2000) presented the incidence rates of anorexia nervosa and bulimia nervosa in Western countries from previous studies as 0.13% and 1% respectively. He suggested that countries with the highest incidence of eating disorders are the UK and the USA. He also indicated that incidence rate of bulimia nervosa was higher than anorexia nervosa.

In terms of mortality, crude mortality rates ranged from 3.3% to 15.9% for anorexia nervosa and 0.3% to 3.1% for bulimia nervosa (Patton 1988; Crisp et al. 1992; Eckert et al. 1995; Sullivan 1995; Keel & Mitchell 1997; Crow, Praus & Thuras 1999). In addition, a few longitudinal studies were conducted to report the standardised mortality rate. One study reported the standardised mortality rate of 6.0 for anorexia patients after their longitudinal assessment during a period of 1971-1981 (Patton 1988). Other longitudinal study used 76 American females showed the standardised mortality rate of 12.8 after 10years of follow-up assessments (Eckert et al. 1995).

Most of the abovementioned studies used females and there are few studies on males. In 1972, both Beaumont, et al. (1972) and Crisp and Toms (1972) reported cases of anorexic male patients in England (six and 13 cases respectively). According to Beaumont, et al. (1972) only 25 anorexic males had been reported previously.

Apart from the epidemiological study by Lucas, et al. (1991), Carlat and Camargo Jr. (1991) conducted a review of English literature through MEDLINE to determine the prevalence of bulimia nervosa among males. From their estimation, 0.2% of adolescent and young adult males were affected by eating disorders, and of these, 10-15% were bulimic. Braun, et al. (1999) reported an increasing trend of male eating disordered patients who were diagnosed by the eating disorders unit of the New York Hospital-Cornell Medical Centre, Westchester Division during the period of 1984-1997. The study reported a significant increase in the proportion of males admitted to the eating disorders unit during this period.

In relation to the proportion who visit hospital, Oliverdia, et al. (1995) recruited 25 college men with eating disorders and compared their symptoms with 25 non-eating disordered males and 33 women with bulimia nervosa through interview. In the study, they found that a smaller proportion of eating disordered males (16%) thought about treatment compared with female counterparts (52%). Hence, it seems likely that the actual proportion of males with eating disorders is much greater than being reported.

One complication of eating disorders among males is that they could develop both ordinal eating disorders as well as a condition known as “reverse anorexia” or more recently as “muscle dysmorphia”. In a study of 108 bodybuilders using structured clinical interview and anthropometry, Pope Jr. et al. (1993) reported that 2.8% of subjects were anorexic and 8.3% of them showed a condition of reverse anorexia.

Non-Western countries have reported a wide variation in the prevalence of eating disorders. Buhrich (1981) studied the frequency of reported anorexia nervosa in those under 30 years old in Malaysia. He obtained information on the patients of 11 psychiatrists, with a mean duration for the period of responsibility for their patients of nine years. Among the total number of 60,000 psychiatric referrals they examined, 28 females and two males were reported to have had primary anorexia nervosa. Buhrich concluded that the incidence of primary anorexia nervosa in Malaysia is rare.

In contrast, Kitamura (1994) studied 43,785 high school students (21,915 females, 21,870 males) in Japan using questionnaires. The study showed incidence rates of eating disorders of 0.18 for females and 0.02 for males. In addition, females of rural high school had higher incidence rate (0.43) than those in urban high school.

From the statistics of prevalence and incidence rates, some studies have stated that eating disorders are the rarest problem among a wide range of psychiatric disorders (Ben-Tovim & Morton 1990). However, it is not true to conclude that eating disorders are not a serious health problem that needs to be focused upon. Epidemiological surveys possess pitfalls in at least two aspects.

Firstly, it is possible that prevalence and incidence rates are significantly higher among specific sub-groups of the entire population, particularly adolescent females. Touyz, et al. (1996) state that anorexia nervosa affects 0.5% of girls aged 15 and 19, which is estimated as the third most common chronic illness in teenage girls, after obesity and asthma. The study by Crisp, et al. (1976) also showed a higher prevalence rate of anorexia nervosa among females aged 16 and above (10.5 per 1,000) compared with females below 16 years old (1.7 per 1,000). For bulimia, the prevalence is far greater than anorexia, and they suggest that about 20% of adolescents receive such a diagnosis (Touyz, Russel & Beumont 1996).

Secondly, and most importantly, due to the prevalence of dieting and the socio-cultural value of thinness, it is possible to expect the presence of a large ‘borderline population’, who are at high risk of developing eating disorders by attempting dangerous weight-loss practices including induced vomiting and laxative abuse — such individuals would not have been diagnosed as having an eating disorder. This point was raised by Touyz, et al (1996). Furthermore, it is worth noting that although DSM-IV® contains the criterion of Eating Disorders Not Otherwise Specified (EDNOS), the prevalence of this disorder has not been emphasized as much as other eating disorders such as anorexia and bulimia nervosa.

2.13.4 Obesity

Many previous studies have focused on distorted body image in relation to the desire for thinness and an excessive concern with fatness. However, body image distortion is also related to the issue of overweight and obesity by not recognising one's own fatness. Generally, excessively large and plump individuals do perceive themselves as being fat. However, moderately overweight or lightly obese individuals often underestimate their body weight. This tendency is more prone among males than females (Cash & Hicks 1990; Rand & Kuldau 1990; Valtolina 1998; Blokstra, Burns & Seidell 1999; Donath 2000; Wardle & Johnson 2002).

Donath (2000) conducted a study using 5,076 men and 5,576 women aged 18 and above living in Australia. They reported that 72% of women and only 49.3% of men who had a BMI equal to, or above 25 perceived themselves as overweight. From these results, they suggested that individuals may possess a different definition of "overweight" from the medical definition. Such misunderstandings may be associated with cultural differences between study groups in what are considered to be acceptable weight levels (Rand & Kuldau 1990).

Overweight and obesity are associated with a number of health problems. According to Wardle (1995), the medical risks of obesity can be divided into two groups: 1) musculo-skeletal or respiratory problems, which are a direct consequence of the obesity, and 2) cardiovascular disease, diabetes or cancer, where obesity is one of the contributing risk factors. People who are moderately overweight require increased health knowledge and understanding to be aware of their health status and to reduce the chance of further increases in health risks. However, a study by Blokstra, et al. (1999) showed poor efforts were being made by the overweight population, in particular males, to reduce their health risk. They examined 2,155 men and 2,446 women aged between 20 and 65 years old and found that 53% of men and 39% of women were overweight or obese and that about 40% of overweight men described themselves as "just right". Also 45% of these men were doing nothing regarding weight management. These results may partially explained by an assumption made by Cash and Hicks (1990) that heavier males may perceive themselves as "big and strong" rather than "fat". Although some suggested that such a cognitive view may protect some overweight men from body image dissatisfaction (Schwartz & Brownell 2004), holding such incorrect perception toward own body will increase the risk of developing serious health problems, including diabetes and cardiovascular diseases.

A problem in many studies (Cash & Hicks 1990; Blokstra, Burns & Seidell 1999; Donath 2000; Wardle & Johnson 2002) is that they used only BMI and did not obtain detailed body composition data on their subjects. As the BMI is only an index of "heaviness" rather than actual body fat deposition, the inclusion of detailed body composition assessments could provide more precise relationship between perception and body fatness (see section 2.6.4 above).

As suggested above, continuous underestimation of one's own physique can result in the development of health problems in the later stages of life, which will impact on quality of life, as well as create long-term burdens on government health budgets. As expressed by Wardle (1995), body image is an important clinical feature of obesity. Hence, the improvement of body image is essential for its treatment and also for prevention.

2.14 Instruments used in body image studies

As shown above, it has been suggested that a distorted body image is associated with various health problems. In order to determine body image and study its association with health problems, a range of assessment instruments have been developed. These assessment instruments vary in style from self-administered questionnaires to the application of advanced technology, such as computer-based programs. Because each instrument differs in the specific information that is designed to obtain, it is important to understand advantages and disadvantages of each style of body image assessment instruments.

2.14.1 Illustrations and Questionnaire-based instruments

The most common body image instrument used in recent studies is the Figure Rating Scale. Other similar methods, such as the Nine-Figure Silhouette Scale and the

Body Figure Perception Questionnaire, are also commonly used (Dwyer et al. 1969; Furnham & Alibhai 1983; Stunkard, Sorensen & Schulsinger 1983; Fallon & Rozin 1985; Bell, Kirkpatrick & Rinn 1986; Rozin & Fallon 1988; Silberstein et al. 1988; Collins 1991; Horne, Van Vactor & Emerson 1991; Lautman 1991; Paxton et al. 1991; Thompson & Altabe 1991; Nelson & Gidycz 1993; Carr-Nangle et al. 1994; Furnham & Baguma 1994; Mildred, Paxton & Wertheim 1995; Thompson 1995; Mukai 1996; Caldwell, Brownell & Wilfley 1997; Parks & Read 1997; Turner et al. 1997; Altabe 1998; Ikeda & Endo 1998; O'Dea 1998; Stevens & Tiggemann 1998; Pierce & Daleng 1998; Lake, Staiger & Glowinski 2000; Schur, Sanders & Steiner 2000).

These methods use a set of illustrations of males or females ranging from very thin to very fat and ask subjects to identify which shape represents their own shape, their ideal shape, and 'attractive shape' as perceived by the opposite gender. The results obtained are then analysed by comparing the image representing the subject with that which represents their ideal shape, in order to calculate the discrepancy between the two. Test-retest reliability, as well as a good correlation with other measures of body image dissatisfaction, eating disturbance, and overall self-esteem were reported for the Figure Rating Scale method (Thompson & Altabe 1991).

There are also other methods based on the Figure Rating Scale, such as the Fat-Slim Persons Inventory (Worsley 1981), Photographic methods (Alley 1991; Craig et al. 1996), the Body Image Assessment and the Body Image Assessment for Obesity (Williamson et al. 1989; Williamson et al. 2000). These were developed to overcome a number of limitations possessed by the original Figure Rating Scale. Furthermore, more technologically advanced methods, based upon these, have been recently introduced. For example, the Body Build (Dickson-Parnell, Jones & Braddy 1987), the Morphing Instrument (Smeets 1999), the Body Morph Assessment (Stewart et al. 2001), and the Somatomorphic Matrix (SM) (Gruber, Pope Jr. & Borowiecki III 1998). Among these computer programs, the Somatomorphic Matrix is the only program that has the potential to assess one's body image in relation to the actual body composition. This is because while the other programs were developed by the modification of photograph size in order to alter the subjects' visual appearance, the SM was developed from anthropometrical measurements of subjects.

As a consequence, the SM program can provide body composition details for each selected figure according to the questions that the subject is being asked. It also allows comparison between selected figures' and the subjects' actual body composition if necessary.

Questionnaires such as the Body Cathexis Scale (Markee, Carey & Pedersen 1990; Verkuyten 1990; Brenner & Cunningham 1992), the Body Shape Scale (Ahmad, Waller & Verduyn 1994), the Ben-Tovim Walker Body Attitude Questionnaire (BAQ) (Ben-Tovim & Walker 1991; Ben-Tovim & Walker 1992; Ben-Tovim & Walker 1994; Wilkinson, Ben-Tovim & Walker 1994), and the Body Shape Questionnaire (Bunnell et al. 1992) are also frequently used by psychologists. However, the questionnaires that have been most frequently used to assess body image are the Body Dissatisfaction and the Drive for Thinness subscales, which are a part of the Eating Disorders Inventory (EDI) developed by Garner, et al. (1983). These subscales have either been used as components of the complete EDI or in some cases have been used independently (Garner et al. 1984; Paxton et al. 1991; Mildred, Paxton & Wertheim 1995; Henriques, Calhoun & Cann 1996; Tiggermann & Pickering 1996; Byrne & Hills 1997; Cusumano & Thompson 1997; Mukai 1998; Braun et al. 1999; Davis & Katzman 1999; Wiederman & Pryor 2000).

Questionnaires and figure scales are convenient, simple, and time efficient. Therefore, they are frequently used across societies and countries. Although these instruments provide certain aspects of information about one's body image, including body satisfaction and perception, they have several limitations that need to be understood in prior to use. The limitations of the silhouette instruments are the issue of limiting response options to one of a finite number of drawings, restricted range of drawings available in the instrument, the method of presentation including the arrangement of the drawings in ascending size from left to right, and the issue of having no standard in the change of body size in the drawings (Gardner, Friedman & Jackson 1998). The most significant limiting feature is that these instruments are fully subjective and that no objective measures are involved. Even if subjects' responses suggest dissatisfaction about their bodies, there is no objective data that confirms or even examines their responses, such as body composition or health outcomes. The Figure Rating Scale usually determines a discrepancy score from the difference between the figures selected according to the questions asked. However, it is not appropriate to determine true body image distortion from the Figure Rating Scale alone. This is because there is no validation of the instruments with regards to the appropriateness of figures and in relation to the subject's real body shape or composition.

2.14.2 Methods with objective measures

While figure rating scales and other questionnaires are instruments that completely rely on subjective assessments, there are methods that use the subject's own body shape as a guide for objective visual representation. The classic example is the distorting mirror method (Brodie & Slade 1988). This method uses a mirror that has the ability to cause concave or convex distortion. Subjects are asked to adjust the image on the mirror to their real body appearance. In comparison to figure rating scales, this method allows the accuracy of visual perception to be assessed, because it uses real images as the indicator. The concept of this method was incorporated into more technologically advanced methods such as the Distorted Television Image Method; other instruments employing similar concepts include the Video Camera Method and the Video Distortion Method (Glucksman & Hirsch 1969; Allebeck, Hallberg & Espmark 1976; Lindholm & Wilson 1988; Whitehouse, Freeman & Annandale 1988; Gardner et al. 1989; Probst et al. 1992; Lautenbacher et al. 1993). Recently, Benson, et al. (1999) has developed a computer program that allows manipulation of body shape and size using the image that was based on a video-captured subject's own physique.

The distorting mirror method and similar instruments focus on one aspect of accuracy in perception. Alternately, there are body image assessment methods that have combined subjective perceptions of body widths with actual widths measured by objective anthropometry. An example of this type of instrument is the Adjustable Light Beam Apparatus. Other similar devices include the Visual Size Estimation Apparatus, the Body Image Detecting Device and the Calliper Apparatus. These instruments allow subjects to assess the widths of certain body parts (eg, head, waist, hip, thigh) and compare the results with their real width values obtained by sliding callipers (Slade & Russel 1973; Ben-Tovim & Crisp 1984; Norris 1984; Willmuth et al. 1985; Thompson & Thompson 1986; Birtchnell, Dolan & Lacey 1987; Dolan, Birtchnell & Lacey 1987; Dolce et al. 1987; Brodie & Slade 1988; Thompson & Connelly 1988; Thompson & Spana 1988; Wardle & Foley 1989; Altabe & Thompson 1990; Thompson & Spana 1991; Myers Jr. & Biocca 1992; Hundleby & Bourgouin 1993; Thompson et al. 1993; Gila, Castro & Toro 1998).

The abovementioned methods are appropriate in assessing the perception of the subject's own body. However, one limitation of these methods is that they allow only the accuracy of assessment of one's body perception with respect to visual appearance — they are unable to consider body composition itself. Nevertheless, these methods and instruments, including figure rating scales and questionnaires, are useful for determining particular body image tendencies within a study group. The methods are also useful in some occasions as a tool for education and to aid in the recovery from health problems. Touyz, et al. (1994) used the videotape feedback method for the treatment of eating disorders. In this technique a video plays the role of a mirror and provides objective information to subjects.

2.14.3 Application of anthropometry in body image studies

It has been suggested that a certain degree of body image distortion is a common phenomenon, which can be observed in almost every individual. However, body image has not been examined in detail in relation to body physique and composition. As the perception of body composition may predispose towards health promoting behaviours, it is important to investigate the extent to which a subject's body image is related to their actual body composition. To determine if the subject's body image was developed on the basis of their current body status and to judge their behaviours with respect to their body image, the application of detailed anthropometry measures, such as %BF, are required. In comparison with body image studies that used self-administered questionnaires, the number of body image studies using anthropometry are still limited (Huenemann et al. 1966; Dwyer et al. 1969; Katch et al. 1982; Enns, Drewnowski & Grinker 1987; Bailey et al. 1990; Eckerson, Housh & Johnson 1992; Huddy, Nieman & Johnson 1993; Davis et al. 1994; O'Dea 1994; O'Connor et al. 1996; Page & Fox 1998; Pierce & Daleng 1998; Edlund, Sjoden & Gebre-Medhin 1999). Of those, some studies have only measured circumferences (Huenemann et al.

1966) or combinations of circumference measurements with single skinfold site (Dwyer et al. 1969; Bailey et al. 1990; O'Dea 1994). Consequently, the number of body image studies with detailed anthropometry is only a small proportion of the entire number of the research that is available today. Possible reasons for this lack of detailed anthropometry are a lack of knowledge and technical expertise among researchers (who mostly have a psychology background), time availability, technical skill for an accurate instrumentation, and also the selection of more convenient health indexes such as the BMI and the WHR.

2.14.3.i) Anthropometry in body image studies

Bailey, et al. (1990) conducted a study on 127 undergraduate females of mixed ethnicities. They assessed the relationship between anthropometric variables and obtained scores from the Eating Disorders Inventory (EDI). Results indicated a significant relationship between lower body girths and body dissatisfaction. However, correlations between girth measurements and questions were relatively low (highest for waist girth $r = 0.29$, gluteal girth $r = -0.20$).

In 1994, Davis, et al. conducted research on 256 females aged between 17 and 48 years old in order to determine the impact of body fat, frame size, and the WHR on body and shape dissatisfaction (Davis et al. 1994). Their results suggested the presence of positive relationships between frame sizes, percent body fat and body dissatisfaction (Davis et al. 1994). Recently, Page and Fox (1998) confirmed these findings using 116 male and 126 female college students (mean age 17.9 years old) in England. They concluded that frame size, in particular the size of the lower trunk is a more important predictor for weight management decision-making among females than fatness level (Page & Fox 1998).

In 1997, Sisson, et al. compared body image of 111 children (49 boys and 62 girls; aged 9-15 years old) together with assessment of their body composition using the Futrex 5000A near infrared interactance (NIR) device. The results suggested overestimation among the female subjects (32%) but a high level of underestimation by the male subjects (49%). However, the major limitation of this study as a cross-ethnic study is the lack of information on the sample population. The researchers only mentioned that 89% of the subjects were Afro-Americans, and did not explain the other ethnic populations involved in the study. In addition, NIR has a question over the validity of its measurements. While some reports on good test-retest repeatability exist (Schreiner, Pitkaniemi & Pekkanen 1995; Fornetti et al. 1999), many studies compared NIR with other body composition assessment methods, such as underwater weighing, bioelectrical impedance analysis (BIA), and anthropometry showed overestimation of body fat among lean subjects and underestimation of obese subjects (Elia, Parkinson & Diaz 1990; Mclean & Skinner 1992; Brooke-Wavell et al. 1995). A further study using dual x-ray absorptiometry (DXA) and a literature review of published data also concluded that NIR cannot be used as a valid body composition assessment method by itself (Panotopoulos et al. 2001; Wagner & Heyward 1999). Several studies recommended a further refinement of prediction equation used in the Futrex 500A to determine body composition of children and adolescents from a comparison with other methods (Cassady et al. 1993; Smith et al. 1997). As a result, the validity of body composition values in the study is questionable and the body image response examined in association with body composition results therefore may not be valid.

As suggested above, there is a very small number of body image studies focused on males. Consequently, studies using anthropometry on males of sufficiently large sample size is very limited.

Huddy, et al. (1993) used three skinfold measurements (chest, abdomen, and thigh) to calculate the percentage body fat (%BF) of 45 male students (15 varsity swimmers, 15 varsity football players, and 15 non-athletes) in the USA. The body image of subjects was assessed using a 20-items questionnaire they developed. Using combined results, they found that subjects possessed an inverse relationship between percent body fat and body image ie, subjects hold an unfavourable body image with the increase in their measured percent body fat.

Joiner Jr., et al. (1994) assessed the relationship between the WHR, body dissatisfaction, gender, and depressed and eating disordered symptoms using 52 males and 79 females in the US. They calculated the Body Mass Index (BMI) from self-reported height and weight and measured waist and gluteal (hip) girths to calculate the WHR of subjects. Subjects were also asked to complete questionnaires to assess their disordered eating and depression levels. In the study, depressed women with high WHR and depressed men with low WHR reported high body dissatisfaction in comparison with mean values. Inversely, high dissatisfaction was observed in non-depressed subjects if the WHR was low for females and high for males. Although the results for females were similar to the one obtained from Bailey, et al. (1990), the study did not clarify the number of “depressed” and “non depressed” subjects for each gender. As subdivision of original sample size makes a smaller number of subjects in each category, in particular for males, the study may have low validity.

Pope, Jr., et al. (2000) assessed college males living in three countries (54 Austrian, 65 French, and 81 American) using anthropometry and the Somatomorphic Matrix (SM) computer program. In comparison to the measured muscularity, the study showed a strong desire to be muscular among males. Their study has one important limitation- the validity of body composition results from the SM program has not been fully confirmed with other criterion body composition assessment methods. Consequently, the results obtained from the SM program cannot be accepted as comparable with measured body composition values unless its comparability is confirmed.

Many body image studies are being conducted from a psychological or psychiatric standpoint. From a public health standpoint, however, the use of anthropometry can obtain information on body composition and also a level of obesity, which are strongly associated with a development of health problems. In order to discuss a distorted body image in relation to overweight or obesity, many have used self-administered questionnaires or a simple index, such as the BMI to assess one’s perceived current fatness or heaviness (Blokstra, Burns & Seidell 1999; Donath 2000). However, the results from self-administered questionnaires are not objective data and the BMI is only an index of heaviness (see section 2.6.4 above) and it does not provide precise information on body composition of individual subjects.

For those studies using anthropometry, many have used girth and bone widths measurements to compare the results with body dissatisfaction or depression levels of the study groups (Bailey et al. 1990; Huddy, Nieman & Johnson 1993; Davis et al.

1994; Joiner Jr., Schmidt & Singh 1994; Page & Fox 1998). Similar to studies using the Adjustable Light Beam Apparatus, studies that only measured bone widths are only capable of assessing a body image that is associated with visual appearance. Although the results of these studies may allow assessment of the risk of developing mental problems such as depression, they are not sufficient to determine whether a relationship between body size and body image distortion can be a risk factor of developing more serious physical health problems such as overweight and obesity. Until today, there is a lack of studies that examined body image with inclusion of satisfactory standard of body composition assessment to discuss its relationship with overweight or obesity.

In addition, it is important to state that no reported study has ever examined whether subjects take their own body composition into a development of their body image or not. As body composition is an important variable in a development of health problems, it is also important to determine the role of body composition in development of the body image. From the result of such study, it may become possible to improve prevention programs for overweight or obesity as well as for unnecessary dieting or disordered eating.

Furthermore, previous studies used different body composition assessment methods (eg, underwater weighing, BIA, DXA, anthropometry) with different protocols such as equipments, measurement sites, and the equations used to predict body composition of the study groups. In addition to the detail of equipments used, many studies did not include information on technical errors of measurement (TEM) hence cause a difficulty in comparison of study results.

Part III. Body composition and body image studies in different ethnic groups, including Japanese subjects

The numbers of studies that are designed to compare differences in characteristics between different ethnic groups, or those living in different countries, are increasing in many research fields. They are classified as "cross-ethnic" or "cross-cultural" studies and aimed to determine the influence of ethnicity or culture to the variables of the interest. In body composition studies, ethnic differences in composition

(Werkman et al. 2000), risk of developing health problems (Deurenberg-Yap, Chew & Deurenberg 2002; Gallagher et al. 2000), and identification of appropriate cut-off points of the index (Deurenberg, Yap & Staveren 1998) are examples.

Study designs to compare ethnic groups have become more common in the years, but terms. However, terms such as "ethnic" and "race", and "culture" and "environment" have been used frequently without clear definition. As they have different meanings, it is important to clarify the differences. The first part of this section includes an overview of cross-ethnic and cross-cultural studies, followed by a review of body composition and body image studies conducted on Japanese subjects.

2.15 Ethnicity and Race

"Ethnicity" and "race" are the two terms that have been used in studies comparing multiple groups of different origin. Wildes, et al. (2001) summarised and defined the term "ethnicity" as:
"A group distinguished by their ancestry, language, customs, religion, culture or nationality."

In comparison to "ethnicity", "race" was defined as:
"The differentiation of groups according to differences in physical characteristics"
(Wildes, Emery & Simons 2001)

It means that while "ethnicity" considers the historical and cultural background of groups, "race" differentiates groups by visual physical differences such as colour of skin, eyes and hair. Therefore, it is more appropriate to use the term "ethnic" rather than "race" in this study, as the study compares physical characteristics as well as their attitudes and thoughts on lifestyles and body image that are based on their cultural values.

2.16 "Culture" and "Environment"

Due to its complex nature, the term "culture" has been given many definitions. In 1871, the anthropologist E. B. Taylor famously defined "culture" as:

“That complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society”

(Helman 1994)

Although the term “culture” has been defined by a number of others, all definitions suggest that culture is a set of guidelines which individuals inherit as members of a particular society, and which tell them how to view the world, how to experience it emotionally, and how to behave in it in relation to other people, to supernatural forces or gods, and to the natural environment (Helman 1994). As culture includes beliefs and knowledge that guide how individuals view the world and behave in society, there is no doubt that what are called “sociocultural values”, which include ideas and concepts relating to health and beauty, are also included in this category.

By contrast, “environment” refers to the materials and products that exist in one’s surroundings to affect one’s living lifestyle. Materials include all available food, open space for exercise, and any products accessible such as clothes, accessories, texts and images. These products do not themselves have beliefs or philosophies, which will be considered as “culture”. However, they often reflect the culture that underlies the environment in which individuals live. For instance, the availability of specific products reflects the culture of the living environment. Consequently, an assessment of environmental variables can indirectly assess cultural influence. However, it is important to be cautious when using environmental variables as a cultural measure, as environmental variables can be different within areas with the same underlying culture, such as rural and urban areas.

2.17 “Cross-ethnic” and “Cross-cultural” studies

“Cross-ethnic” studies usually refer to studies which aim to compare differences in study topics between ethnic groups, whereas “cross-cultural” studies are those focused on differences between groups living in different cultural environments. However, several points from previously conducted cross-ethnic and cross-cultural studies need to be considered.

Although it is the case for any form of study, the classification of the study group is particularly important for cross-ethnic studies. The ideal classification is by ethnicity, such as "Singapore Chinese" and "Singapore Malays". In the case of highly multi-ethnic nations such as Australia and the US, subdivision into small groups according to region-for example, Asians in the Middle East; country-for example, Japanese; or society-for example, Chinese Americans; may produce groupings that have more chance of sharing similar cultural values. This is to avoid mixing physical characteristics and cultural values, which may cause interference to the study topics. However, many existing cross-ethnic studies classify groups into very broad groups such as "Asian", "Caucasian", "Hispanic", and "Afro-Americans". For example, in terms of latitude, "Asia" covers Japan/China to Turkey/Iraq, while longitudinally it covers all Central Asian countries, such as Uzbekistan, to Indonesia/Malaysia. Considering that there are a large number of subpopulations living in Asia, such as Mongolian Asian and Euripides Asian, as well as mixed blood of both ethnic backgrounds, use of the term "Asian" is too broad and vague. Similarly, although their origin is the same, Afro-Americans and those living in Africa have different cultural values and hence the use of the term "Black" is inappropriate.

"Cultural differences" not only occurs between groups living in different countries, but can also occur between different groups living in the same society and country. Helman (1994) has stated that as most societies have some form of social stratification, differences in culture can occur between social classes. These can be observed in the form of differences in linguistic usage, dietary patterns and styles of dress. Cross-cultural studies using different ethnic groups require the differentiation of outcomes that are due to "ethnic" and "cultural" influences. The vast majority of existing cross-cultural, cross-ethnic studies that have obtained and compared data have used the following study designs:

I. Comparison of different ethnic groups living in the same country (eg, Afro-Americans and White Americans living in the US (Wilfley et al. 1996)).

II. Comparison of the same ethnic groups living in different countries (eg, Koreans living in South Korea and Koreans living in the US (Ko & Cohen 1998)).

III. Comparison of different ethnic groups living in their home countries (eg, Australians and Polynesian Maoris (Craig et al. 1996)).

IV. Comparison of groups of the same ethnic origin living in the same society having different levels of cultural exposure (eg, 1st generation and 2nd generation Japanese living in Hawaii (Wenkam & Wolff 1970)).

V. Comparison of groups of the same ethnic origin living in different countries (eg, Caucasian males living in Austria, France and in the US (Pope Jr et al. 2000)).

Design I aims to assess any ethnic differences between groups in the same society and it is the most frequently used design for cross-ethnic studies. However, it is not appropriate to conclude from the findings of this study design that such ethnic differences can be applied to other locations. This is because the examining site has its own cultural base, which may be different from other locations. Hence the ethnic groups tested in one site may have developed their own specific cultural backgrounds. As a result, confirmation of any differences in ethnic characteristic according to their living location is required prior to considering generalisations. Assessment of characteristics of the same ethnic populations living in different countries can be done by using study design II or similar.

Design III is also commonly applied in cross-ethnic, cross-cultural research, possibly due to convenience of data collection. However, this design only produces ‘baseline data’ to suggest any existence of differences among study topics in these major populations living in different countries, and it is difficult to clarify what has caused these differences. It can suggest cultural influences on observed ethnic differences, only if assessing groups were recruited from completely different societies, such as the US and Aboriginal tribes living in a traditional manner. Because of increased cultural diversity and exchanges in the current societies, it is important to assess differences in “cultural levels”, or the influence of other cultures, in particular Western culture, to the life of the population living in the society, prior to raising suggestions of ethnic or cultural impacts. Design IV can be used to assess the cultural values possessed by different study groups having the same ethnic origin.

Also, findings from studies using designs IV and V might be difficult to analyse in instances when the definition of the study group has not been specified clearly. For instance, both Japanese Americans with two genuine Japanese parents and those with one Japanese parent can be classified as "Japanese-originated Americans", unless otherwise specified in detail. However, Japanese Americans with two Japanese parents are more likely to have physical characteristics similar to the Japanese living in Japan in comparison to those with only one parent of Japanese origin. Consequently, these two groups should not be considered as combinable unless their similarities had been confirmed. In contrast, these study designs are useful if aiming to assess differences between groups.

To detect any differences or changes in research topics, and to differentiate the cause of differences as being either from an "ethnic" or a "cultural" influence, a "triangular" study design is ideal. The triangular design is a cross-sectional study design that obtains baseline data for groups living in their home countries and compares this to the group of interest living in a different country in order to assess any differences. However, probably due to the difficulty of recruitment of subjects, almost no study has been conducted with this specific design. Alternatively, assessment of a single group who have moved to a country of a different cultural background from their home country, by means of a follow-up study could be an effective study design to determine the impact of change in culture. Again, this study design is uncommon, especially in the field of body composition, lifestyle and body image. Appendices Five and Six list cross-sectional and longitudinal studies that have assessed body image issues using multi-ethnic study groups. As these Appendices clearly show, many are cross-sectional and most focus on females. Also only a few studies have used a "triangular" study design. It is also important to emphasise that many used only self-administered questionnaires and did not focus in any detail on body composition, which is strongly associated with development of health problems.

2.17.1 Body image studies in cross-ethnic, cross-cultural design

It has been suggested that the current trend of the thin-ideal body image is strongly associated with the Westernisation of the world. Several cross-ethnic studies have compared the body image of individuals living in highly developed, or highly "Westernised", countries with those of non-Westernised countries. The results showed a more consistent trend that those from non-Westernised countries which were less preoccupied with their level of fatness and rather, they preferred plumper figures over thin figures. This trend was confirmed by studies comparing the same ethnic groups living in Western societies and their own countries, as well as by a study that compared an older population with a more traditional body image than that with a younger population who had been more exposed to Western values through the media.

This difference in body image between Westernised and non-Westernised areas is largely due to living conditions. Historically, those who have preferred plump body images are those who have, by necessity, been focused on survival. In such cases, a plump body image is seen as one of wealth, sufficient food supply, and a higher delivery rate for females, which consequently leads to greater survival rates than for those who aren't plump. In most Western, developed societies, most residents have access to sufficient food to maintain an adequate level of nutrient intakes. At the same time, people living in these societies have knowledge of the adverse health effects of being overweight and obese. Consequently overweight or obese individuals living in these societies are likely to be perceived as lacking their self-control. In addition, the wave of information encouraging a thin-ideal accelerates their preoccupation with thinner bodies.

Acknowledging the above-mentioned strong link in the difference between body shape and lifestyle, the existence of body image differences between Westernised and non-Westernised societies is not surprising. However, greater attention should be paid to body image differences between groups that are living in highly Westernised or developed societies. The presence of body image differences between sub-groups living in the same society, or in societies of similar levels of Westernisation, may allow identification of specific sub-groups with distorted body images, who are thus at risk of developing related health problems. In the US, a number of studies were conducted using Afro-Americans and other ethnic groups (Flynn & Fitzgibbon 1998; Fitzgibbon, Blackman & Avellone 2000). These concluded that Afro-Americans preferred plumper body images than their Caucasian counterparts. These results not only suggested a risk of unhealthy dieting behaviours and of developing eating disorders but in fact, they also indicated that the comparatively smaller focus paid by Afro-Americans on their body may result in the prevalence of overweight and obesity. Unfortunately, there have been no reported studies that follow-up this original report.

Overweight and obesity can occur even though individuals look thin because the actual amount of body fatness (ie, %BF) is more important than appearance or weight. Therefore, it is important to construct a body image that includes actual body composition as a variable of its formation. The application of body image to identify risks of overweight and obesity is a missing link between Psychology and Public Health in the development of prevention strategies.

2.18 Japanese studies

2.18.1 Westernisation in Japan

With a period of modernisation after the end of Edo period, Japan underwent industrialisation, and improvement in food supplies. In addition a number of Western practices including diet, clothing, and lifestyle have been adopted. There has been a significant secular trend in growth and life expectancy is now one of the longest in the world.

With regard to dietary patterns, the balance of nutrients consumed by Japanese people has changed dramatically since the end of World War II. Energy consumption from carbohydrates has reduced from 79.7% of total energy intake to 55.8%, for the period of 1950-1994. In contrast, intakes of energy from fat and proteins have increased for the same period by the following amounts: fat: 7.7% to 25.8%, and protein: 13% to 15.8%. In addition, while energy intake from cereal products has reduced, there has been an increase in energy intake from animal protein (Kagawa 1997).

Improvements in diet also improved the physical characteristics of Japanese populations. Both 14 year old boys and girls showed a rapid increase in their heights and weights after World War II (Kagawa 1997). Wenkam and Wolff (1970) reported an improvement in physical characteristics as the consumption of a Westernised diet increased among Japanese immigrants living in Hawaii. This suggests an important role of diet in the change of physical characteristics.

At the same time, the leading cause of death has changed from infectious diseases, such as pneumonia and tuberculosis, to chronic diseases, such as cancer and cerebrovascular and cardiovascular diseases —many of these being diet related. This trend, the "epidemiological transition", is similar to that undergone earlier by Western countries such as France, Italy, Holland, the US, Austria, Australia, New Zealand, and Germany in the 19th and early 20th centuries (Miyagi 1992; Kagawa 1997). Japan has now passed through an epidemiological transition similar to most Western societies and has similar living conditions to many Western countries. Life expectancy is now greater than most western countries.

2.18.2 Body composition studies in Japan

Due to its strong association with health problems such as obesity and cardiovascular diseases, the topic of body composition has been widely studied in Japan. At the national level, a national survey has been conducted every years to show secular trends of stature, body mass, BMI and incidence of obesity (KEJK 2004). Similar surveys have been conducted at the prefecture level. In addition, Japanese researchers have been providing body composition data for both general and specific subjects (Ohmura et al. 1997; Tahara et al. 2002a; Tahara et al. 2002b).

The earliest body composition research conducted in Japan was by Nagamine and Suzuki (1964), which measured the body composition of Japanese males and females by densitometry (the water displacement method) and anthropometry. The study compared the results with the available data in the US and developed a body density (BD) prediction equation using anthropometry variables. Many researchers are still using BD prediction equations developed from the study. Later, there was a study aimed to determine the body surface area from assessment of height and weight using a time consuming, direct paper coating technique (Takai & Shimaguchi 1986). Today, advanced body composition assessment methods, such as dual energy x-ray absorptiometry (DXA) (Ito et al. 2001), ultrasound (Abe & Fukunaga 1995) and, more recently, BOD POD® (Miyatake, Nonaka & Fujii 1999), a newly developed air displacement method, have been introduced in the body composition studies conducted in Japan.

A trend towards overweight/obesity among Japanese was reported by Yoshiike, et al. (2002) using previous reports of the National Nutrition Survey results. According to their findings, the mean BMI increased among males and slightly decreased among females, after age adjustment. However, the decreasing trend of the BMI among females is very high among the specific age group of 20 to 29 years old. In terms of the prevalence of overweight and obesity, the rate of males has increased from 14.5% pre-obese and 0.8% obese during the period of 1976-80 to 20.5% pre-obese and 2.0% obese during the period of 1991-95. In addition, in contrast to the female trend, males aged between 20 and 29 displayed the greatest increase in becoming overweight and obesity.

A concern must be raised about the classification of overweight and obesity using the BMI. The majority of Japanese studies have used a BMI classification defined by the Japan Society for the Study of Obesity (JASSO), which classifies a BMI value of 25 as the cut-off point for obesity. Other studies use the ordinary WHO classification, which classifies a BMI value of 25 as the cut-off point for pre-obesity (Matsuzawa et al. 2000). However, recent studies have reported that Asians tend to possess a greater %BF than Caucasian populations, even at lower BMI values. Similarly, other studies suggested that Asians have a higher risk of developing obesity-related health problems such as diabetes at lower BMI values (Gallagher et al. 2000; Deurenberg, Deurenberg-Yap & Guricci 2002; Lee et al. 2002). As a consequence, together with the International Association for the Study of Obesity (IASO) and the International Obesity Task Force (IOTF), WHO has proposed a specific BMI classification for the population of the Asia-Pacific region, which designates a BMI value of 23 as the cut-off point for overweight (at risk) (WHO/IASO/IOTF 2000) (Table 2.2). While this new classification is currently under assessment, very few studies have utilized it to assess levels of overweight or obesity among Japanese subjects. Consequently, it can be assumed that, by using the new classification, a relatively large proportion of the Japanese overweight and obese population might be identified.

Table 2.2 Differences in cut-off points for obesity between available BMI classifications

BMI	JASSO*	WHO**	BMI	New Asia-Pacific Classification***
<18.5	Underweight	Underweight	<18.5	Underweight
18.5≤ - <25	Normal range	Normal range	18.5≤ - <23	Normal range
25≤ - <30	Obese class I	Pre-obese	23≤ - <25	Overweight (at risk)
30≤ - <35	Obese class II	Obese class I	25≤ - <30	Obese class I
35≤ - <40	Obese class III	Obese class II	30≤	Obese class II
40≤	Obese class IV	Obese class III		

* JASSO stands for the Japan Society for the Study of Obesity. The classification adopted from Matsuzawa, et al., (2000).
** WHO stands for the World Health Organization. The classification was adopted from WHO (1997a).
*** The Asia-Pacific classification was adopted from WHO/IASO/IOTF (2000).

2.18.3 Body image trends in Japan

2.18.3.i) History of body image preference in Japan

As suggested by Brown (1998), and as many societies have experienced, the body image of Japanese society has been altered by the availability of sufficient food (Kouda 1996). A moderate level of obesity was viewed as an indication of wealth during the eighth to 12th century, and during this period only noble families could consume sufficient amounts of food. At the same time, those who were excessively obese were perceived as having an illness. There are records that some noble people from this period who were overweight tried to reduce their weight.

Japanese body image altered in the Edo era (1603-1867AD), as townspeople became capable of storing their wealth. In the Edo era, people preferred women with "yanagi-goshi" (meaning "a willow-like waist"). Literature from the period showed that females in the Edo era possessed a fear of becoming obese (Kouda 1996). This may indicate a transition in the image of the ideal female body from one that is plumper to one that is thinner. This transition is however, not exactly the same ideal female image possessed in the Western society. Kamohara (2001) stated that Japanese females in the Edo era preferred a thin waist but unlike Western females, they did not prefer large breasts. The background to this change is not only the increasing ability to become wealthy but also a flourishing period of Japanese traditional cuisine, with dishes such as sushi and Japanese noodles, which made it easy for people to gain weight.

The Japanese ideal body altered again after World War II, when lifestyle and diet further changed. The Japanese physiological proportion, for example stature, has changed dramatically, and in 1953, a Japanese female received the third place award in the Miss Universe contest for the first time ever (Kiriike, Nagata & Shirata 1996; Kiriike 2000). This event clearly indicated the transition of the Japanese physique to that possessed by Western contestants; it also seemed to alter the population's standard of "beauty" from a face-oriented standard to a more proportion-oriented standard (Kiriike, Nagata & Shirata 1996). In comparison to the historical transition of ideal female image that has been focused, there is no literature that clearly stated the historical ideal male image in Japan.

The National Nutrition Survey conducted by the Ministry of Health, Labour and Welfare showed an increasing trend towards thinness (ie, decline of the BMI) among females, particularly among young women aged 20 to 29 (Kawano 2000; KEJK 2004). Several studies that have also assessed this trend, suggested that it began in the mid- to late 1960's (Okuno & Haraguchi 1992; Kiriike, Nagata & Shirata 1996). The most recent survey suggests the presence of a large proportion of young males and females who have been classified as being thin (8.1% males and 26.0% females) (KEJK 2004). While this decline of BMI could be partially explained by the rapid drop of total energy intake from the mid-1970s and the gradual fall of carbohydrate intake (Kiriike, Nagata & Shirata 1996), it cannot be denied that a preoccupation with thinness partially lead to such a drop in the energy intake of Japanese, especially females. In addition, various dieting methods are popular among Japanese people due to their preoccupation with thinness, and recently this unnecessary preoccupation has lead to death. In 2002, at least four people were killed and 158 other had liver and thyroid disorders as a result of consuming an unknown "herbal" diet aid from China (Watts 2002).

Although females tend to possess a greater preoccupation with proportion and thinness then males, recent studies have suggested approximately one third, or a higher proportion, of male adolescents are also over-concerned about their appearance and proportion (Takeda, Suzuki & Matsushita 1993; Takeda, Suzuki & Muramatsu 1996). This may be due to the recent trend among Japanese people to perceive thin, slim, and more unisexual-figured males as attractive, more than males with big and muscular physiques (Takeda, Suzuki & Muramatsu 1996). Such a change may also indicate a change in men's attitudes from "selecting" a partner to "being selected" by a partner (Ishihara 2000).

2.18.3.ii) Eating disorders in Japan

As mentioned by Dolan (1991), anorexia nervosa is well recognised in Japan. There are records of illnesses similar to anorexia nervosa in the Edo era (Kiriike 2000). While Bruch (1974) mentions an increased incidence of reported eating disorders among Japanese after World War II, Davis and Oswalt (1992) have stated that anorexia nervosa has only been frequently reported in Japan since the mid-1970s. Several studies conducted in different hospitals support this view (Takagi 1998; Suematsu & Kuboki 1998). Based on a study conducted in 1988, Takagi (1998) stated that there was a nine-fold increase in eating-disordered patients at one hospital during the period from 1972 to 1985. By assessing the National Patient Survey that is conducted every three years by the Ministry of Health and Welfare, Inaba (1996) suggested a rapid increase in eating- disordered patients since 1984. The recent National Survey (1996) showed more than a two-fold increase in the number of patients in comparison with the previous survey conducted in 1993, while another study suggests a 10-fold increase for the incidence of eating disorders in last 20 years (Ohno, Nakao & Nozoe 1998).

Ohno, et al. (1998) also raised a concern that figures from their survey may underestimate a relatively large proportion of sufferers. This is because the majority of eating-disordered patients decided to seek medical assistance only when they experience severe symptoms, and otherwise tend to deny their symptoms. A study by Watanabe and Tsubota (1998) reported that 41% of all eating-disorder cases studied had been severely thin since their childhood and schooling period, yet had not been recognised until the development of eating disorders. Ishihara (2000) has mentioned the recent trend of the declining age of eating-disordered patients. According to her report, there has been an increase in eating-disordered primary school students; in 1990, one hospital reported a decline in average age from 18.9 years old in 1985 to 14.3 years old. She also mentioned that since 1983 there had been a three-fold increase in eating-disordered patients aged below 15.

The prevalence rate of anorexia nervosa in schoolgirls varies between studies (Kobayashi 1988; Kitamura 1994; Mukai, Crago & Shisslak 1994; Nakamura et al. 1999). The prevalence of cases was estimated as one in 500 for urban areas and one in 2000 for rural areas (Dolan 1991; Kitamura 1994). A study by Shiga, et al. (1994) has suggested a difference in behaviours and attitudes toward body image among female high school students, depending on their area of residence.

As preoccupation with their appearance increases, the incidence of eating disorders among males is also rapidly increasing. While the ratio of eating disorders between females and males in 1985 was 25 to one, it reduced to 19 to one in 1990, and recently became nine to one (Nagata 2000). Takeda and his colleagues assessed the prevalence of bulimia nervosa among Japanese male students at high school and university and compared the results with those of females (Takeda, Suzuki & Matsushita 1993; Takeda, Suzuki & Muramatsu 1996). Using the criteria of DSM-III®-R, they found 0.7% of male high school students were identified as bulimic and that there was no distinct difference with their female counterparts (Takeda, Suzuki & Matsushita 1993). For university subjects, although only 0.4% of male university students were found to be bulimic, the proportion of males and females who answered that they had a history of binge eating twice a week were 3.6% and 4.2% respectively, indicating no significant differences between genders (Takeda, Suzuki & Muramatsu 1996).

Rapid increases in the incidence of eating disorders among Japanese increases the need for all aspects of prevention and treatment, as well as the clarification of factors associated with eating problems and disorders for this ethnic population. In addition, it is important to acknowledge that other study has reported the presence of a relatively large proportion of subjects who cannot be classified as eating-disordered, yet who possess certain symptoms of disorders (Tsutsui et al. 1994).

2.18.3.iii) Body image responses

Distorted body image is more common among Japanese females than males, a similar situation as is found in Western countries. Sakuma and Rikimaru (1993) conducted a study on female college students to assess their self-perception. While "medically" obese included only 10 percent of the subjects, approximately 60 percent of the subjects perceived themselves as being obese. Similarly, a study conducted by Taguchi and Nakajima (1995) reported that 63% of 367 female university students perceived themselves as "being fat", whilst 46% of them were in fact categorised as falling within the "normal" BMI range. Fujimoto (1998) also reported that 57.2% of 305 female university students perceived themselves as "being fat" and 73.4% of all subjects were not satisfied with their current body shape. To support their finding, the difference between the mean current BMI figure and the mean ideal BMI figure was recorded and found to be as follows: mean current = 20.7, and mean ideal = 18.3. Furthermore, another report suggested that 95.2% of females and 62.5% of males do not want to be overweight (Eda & Imi 1995).

The regional health survey conducted in Tokyo has assessed ideal BMI on 827 individuals. Results showed that the majority of males (74.1%) aged 20 to 29 years old suggested BMI values ranging from 19.8-24.2 as their ideal, which is within the normal category. However, the majority of females (80.7%) of the same age group suggested BMI values below 19.8 as their ideal BMI. The most recent National Survey revealed that while the actual BMI of young females is already under 22, which is considered as the lowest health risk in Japan, their ideal BMI is much lower (18.7 for 15-19 age group, 19.1 for 20-29 age group) (Kawano 2000)

2.18.3.iv) Body image in relation to body composition

There have been no reported studies that applied body composition assessments to determine body image of Japanese subjects. This is probably due to the fact that in order to determine the "fatness" of subjects many Japanese studies choose simple indices such as the BMI and %Mean Matched Population Weight indices, rather than formal, appropriate body composition assessment methods (Matsuura et al. 1992; Sakuma & Rikimaru 1993; Eda & Imi 1995; Ikeda & Endo 1998).

One of the issues often discussed in Japan is "Masked obesity" (Ikeda & Endo 1998). It is said to be a condition of individuals who appear thin or normal but possess a large amount of body fat. It has been thought that this form of obesity could be due to dieting attempts without accompanying physical activity to lose weight, which may result in a loss of lean body mass and an increase in the proportion of fat mass (Kajioka et al. 2002). Masked obese individuals do not visually appear overweight or obese and as a result, the Waist-to-Hip Ratio (WHR) may not detect the presence of this obesity. Simple indices used in many body image studies are only a measure of heaviness and inappropriate to assess more health-related variables such as %BF or abdominal deep fat. Consequently, to address the presence of masked obesity among Japanese, body composition assessment methods superior to simple indices should be used. The use of the term "masked obesity" is not common in the West. However the topic may reflect the use of the Western BMI cut-off points instead of cut-off points more appropriate to the society. If a BMI classification that does not reflect the body composition of the study population is applied, a large proportion of subjects with excessive fat deposition could be classified as "normal". These people would have a "normal" BMI but a higher proportion of fat than Caucasians of the same BMI level. Since %BF is the physiological parameter that determines health, this is often termed "masked obesity".

2.18.4 Japanese in cross-ethnic, cross-cultural studies

2.18.4.i) Body composition studies

With respect to cross-ethnic and cross-cultural aspects, the Japanese have rarely been assessed and compared as a group. In addition, many comparative studies have used female subjects; a smaller number used males. Ishida, et al. (1992) examined the difference in fat and muscle thickness between Japanese (n = 36) and American (n = 42) women using B-scan ultrasound. They found no significant difference in %body fat between ethnicity, but did find a much larger fat free mass (FFM) in American women in comparison to Japanese women. Kin, et al. (1993) studied the difference in bone density and body composition of Japanese who were born in Japan (n = 137) and in the US (n = 151). Their results indicated that the US born Japanese had significantly higher body fat than the immigrant Japanese. Wang, et al. (1994) included nine Japanese as a part of their 242 "Asian" group in their study of cross-ethnic body composition, to assess the correlation between the BMI and percent body fat (%BF), measured by dual photon absorptiometry; the age of subjects ranged from 18 to 94 years old. Although there were limitations, including the small proportion of Japanese subjects in the total "Asian" group and no details about gender ratio, Asians were found to have a lower BMI but higher percent body fat than were the White subjects (Wang et al. 1994).

In comparison with females, a fewer numbers of cross-ethnic body composition studies used Japanese males. Since the study by Nagamine and Suzuki (1964), many studies compared results that were compiled from other research of different methodologies (Kitagawa 1978) or use small sample size (Nakanishi & Nethery 1999). Curb and Marcus (1991) conducted a prospective study on Japanese males aged between 45-69 years old who were living in Japan (n = 2,183), Hawaii (n = 8,006), and California (n = 2,296). They used anthropometry, blood assessment, and 24 hour recall to determine a health risk of Japanese males living in different environments. They found significantly lower BMI and subscapular skinfold values of Japanese living in Japan compared to those living in overseas. In addition, they found that energy contribution from fat in the diets of Japanese men in Hawaii was two times higher than that of Japanese men living in Japan. In comparison with other studies, this study uses huge sample size. However, this study used middle aged males and also there was little information on methodology, including the assessment of over- and under-reporters of food intakes.

2.18.4.ii) Body image studies

Due to further increases in immigration to foreign countries and more opportunities of being exposed to different cultures, researchers should study the influence of these environmental changes to gain insights into public health issues. However, there are few studies assessing body image among Japanese immigrants or temporary residents. A possible reason is probably the convenience of recruiting other Asian subjects living overseas, such as Chinese, as representatives of Asian subjects (even though the cultural backgrounds possessed by every Asian population varies). Consequently, little is known about Japanese living overseas and their differences from Japanese living in Japan, or other ethnic groups.

Gustavson, et al. (1993) have assessed the degree of body image distortion of 127 Japanese females and compared it with the results of 286 Costa Ricans and of 395 Americans. They stated that, even though they found a negative association between stature and body image distortion, there were no reliable differences in body image distortion between gender and cultural groups. However, their study was lacking in methodological information and its validity is thus in doubt.

A study conducted by Lucero, et al. (1992) included Japanese females as a part of their 111 Asian female subjects. However, as details of the subjects were not given, it is not appropriate to view the results as Japanese-specific.

A study by Learner, et al. (1980) examined psychological functions such as self-esteem, self-concept, and body attitudes of 796 Japanese living in Japan (50.4% were females) and existing comparative American adolescents datasets collected in the US. They found that the Japanese tended to have a lower self-esteem and saw themselves as less attractive than their US counterparts (Lerner et al. 1980). As a strong association exists between poor self-esteem, poor body image and the development of eating disorders, this result may indicate the high risk of Japanese adolescents living in Japan developing eating disorders.

Although their primary focus was not on body image, Furukawa (1994) and Waller and Matoba (1999) have investigated the impact of living overseas on eating behaviours and psychopathology. Waller and Matoba (1999) investigated the relation of emotional eating and psychological functioning among three groups of 30 females (aged between 18 and 30 years): Japanese living in Japan, Japanese living in the UK, and British living in the UK. As reported by Learner, et al. (1980), they found that Japanese women living in Japan showed a lower level of self-esteem than the other two groups living in the UK. In terms of the association between emotional eating and eating psychopathology, Japanese living in the UK showed a pattern of association between eating behaviour and psychological functioning that was relatively similar to that shown by British subjects. Waller and Matoba (1999) suggested that the difference between Japanese subjects was due to “cross-cultural” differences and “acculturation”, even though they also stated that there was no relationship between observed results and the duration of residence for Japanese women living in the UK. Acknowledging the differences obtained from Japanese living overseas and those living in Japan, they stated the possibility of "selective migration", namely, that immigrants immigrate to a foreign country because their behaviours originally fit with those of the country to which they immigrate (Waller & Matoba 1999). Due to the limitations of cross-sectional study design, both Learner, et al. (1980) and Waller and Matoba (1999) recommended a study with a longitudinal design in order to observe the changes in behaviour.

Furukawa (1994) has conducted a longitudinal study to investigate changes in eating attitudes and weights of adolescents who experienced home-stay overseas. He examined 102 females and 42 males prior to their departure and six months after the placement in a host family, using the Maudsley Personality Inventory, the General Health Questionnaire, the Parental Bonding Instrument, the People In Your Life scale and the Eating Disorder Inventory (EDI) (Furukawa 1994). After the stay, both genders reported a significant increase in their weight. In addition, although both genders showed similar scores for all subscales of the EDI both before and after experiencing non-Japanese cultures, a substantial proportion of subjects experienced abnormal eating attitudes during their stay overseas: 20% of females and 10% of males (Furukawa 1994). Furukawa (1994) found a strong positive association between neuroticism and the drive for thinness, whether or not subjects were under acculturative stress. He also found that individuals with stronger perfectionist tendencies and less interoceptive awareness reported a greater drive for thinness. From the results obtained, Furukawa (1994) concluded that:

"Japanese adolescents, having already been exposed to socio-cultural pressures for slimness, gain weight under the general stresses of acculturation but do not respond with a greater frequency of pathological eating attitudes regardless of whether they are placed in weight-conscious cultures or not. Rather, intra-individual characteristics such as personality and cognitive traits and perceived parental rearing, emerged as predictors of future pathological eating patterns under stressful situations." (Furukawa, 1994, p78)

While these studies focused on and emphasised eating behaviours and the possible development of eating disorders and problems, there are almost no studies that specifically focus on the body images of Japanese living overseas. That is, there are no previous data that compares the body image of Japanese living overseas with those living in Japan, or with other ethnic groups, to confirm the presence of body image differences.

Part IV. Significance

2.19 Significance of this study

2.19.1 Need for further cross-ethnic, cross-cultural studies using Japanese

The total number of Japanese immigrants is increasing every year. According to the most recent report by the Ministry of Foreign Affairs of Japan (MOFA 2002), the total number of Japanese living overseas was 837,744 in October 2001, which is a 3.2% increase from the previous year. The countries of greatest immigration and long-term residency for Japanese (stays more than three months but not taking out Permanent Residency Visas) are the US, Brazil, and China.

The Ministry of Foreign Affairs report suggests that the Oceanic region has 56,205 Japanese inhabitants and of these, 41,309 live in Australia. The Japanese living in Australia can be further broken down as follows: long-term residents: 22,808; permanent residents: 18,501; Males: 22,336; and females: 33,869 (MOFA 2002). This is equivalent to 6.7% of total Japanese inhabitants living overseas and the population of Japanese living in this region increased by 8.3% from the previous year, which is the greatest increase among all other regions in comparison to the previous year. Australia ranks fifth in the top 50 countries receiving Japanese immigrants, and major cities such as Sydney, Melbourne, Perth and Brisbane ranked in the top 50 cities receiving Japanese immigrants.

At the same time, the number of immigrants to Japan is also increasing. According to the most recent report by the Ministry of Justice (MJ) (2002), the number of foreign residents has been increasing for the last 33 years, and in 2001 the total number of foreigners living in Japan was 1,778,462. This represented a 45.9% increase from 10 years earlier. Immigrants were from 182 countries with the major nationalities being Korea and North Korea, China, Brazil, Philippines, Peru and the

US. These immigrants mainly live in the prefectures of major cities such as Tokyo, Osaka and Nagoya, but the proportion of immigrants is increasing in the vast majority of prefectures.

These reports indicate the tendency towards globalisation and the multi-ethnic environment of the societies in which many Japanese live today. However, there are only a limited number of Japanese studies that have incorporated cultural and ethnic variables into the assessment of health issues. In addition, many available studies simply compare Japanese living in Japan with other ethnic groups living in their home countries. A very small proportion of research has focused on Japanese who have emigrated or are living overseas, regardless of whether this is a permanent or temporary arrangement.

Although the degree of multi-ethnicity in Japanese society has been increasing, differences in the interaction of environmental variables for those living at home and for those living overseas can be assumed, as they are living in environments of different underlying cultures. Japanese living in Japan can maintain Japanese traditions within their lifestyles. Environmental variables that may interact with health status include diet, physical activity levels, and body composition (which is possibly a consequence of changes in the first two variables).

It has been suggested that a group of individuals living in a different country will have a tendency to alter their eating behaviours (Pan et al. 1999). For those living overseas for longer periods, other studies have shown a change in anthropometry variables, such as stature and bone density (Wenkam & Wolff 1970; Kin et al. 1993). Several studies have been conducted using residents of Japanese descent living in Hawaii, to reveal relationships between several types of cancer. These studies suggested that the risks of developing diseases among elderly Japanese living in Hawaii were greater than they were for those living in Japan (Goodman 1991; Huang et al. 1996). The studies concluded that the traditional Japanese diet might have had a beneficial effect in preventing the development of cancer.

The abovementioned studies presented findings from groups who had lived in foreign countries for long periods; it is very unlikely that similar results would be observed among groups of temporary residents. However, it is also unlikely that many individuals living in foreign countries could maintain a diet that was similar to that which they were used to in Japan. Yet, it is also true that the exact difference in nutrient intake between groups living in Western countries and in Japan has not been confirmed. Consequently, there is a need to assess any differences in nutrient and energy intakes due to living in different countries.

In addition to changes in diet, there may be differences in physical activity levels that are possible by living overseas. This is another reason why those living overseas may have a different body composition from those living in their home country. If there is a difference in body composition between groups, there is a need to identify the predisposing factors to that change.

Furthermore, a large proportion of currently available cross-ethnic, cross-cultural studies focus on females or the elderly (Kin et al. 1993; Kim et al. 1993); there is a lack of data for young males. Consequently, there is only a limited amount of data on the impact of different levels of cultural exposure, and of living under a multi-ethnic society, upon the Japanese population in particular, in relation to their health risks.

2.19.2 Need for further study on Japanese body composition

As stated above, there are a limited number of cross-cultural, cross-ethnic studies using Japanese subjects. Although there are some studies conducted in the field of anthropometry, assessing bone density, total body fatness and subcutaneous adipose tissue differences using various methods (Nagamine & Suzuki 1964; Ishida et al. 1992; Sugimoto et al. 1992; Kin et al. 1993; Abe & Fukunaga 1995; Gallagher et al. 2000), the majority of these studies were conducted on females and older age groups. There is very little information on young Japanese males in comparison with other ethnic populations.

One of the current issues in body composition studies is a suggestion that BMI cut-off points defined by the WHO are not appropriate for the entire world population (Deurenberg 2001). Various studies have shown that the relationship between the

BMI and the corresponding %BF is different for each ethnic group (Wang et al. 1994; Deurenberg, Deurenberg-Yap & Guricci 2002); further, a recent meeting has proposed different cut-off points for Asians (WHO/IASO/IOTF 2000). While there are studies on a range of ethnic groups to assess difference in such BMI-%BF relationship, few of these studies include Japanese subjects (Gallagher et al. 2000; Tomosaka et al. 2002).

The deficiency is not restricted to Japanese subjects in particular; there are a limited number of studies that examine the appropriateness of using existing body composition assessment equations such as BD or %BF prediction equations for the same ethnic groups living in different environments. These prediction equations are population-specific and living in a different environment may have an impact on the human body composition. Consequently, even if they are of the same ethnic backgrounds, it is questionable to apply the same equation to groups living in different countries if dietary factors and physical activity levels significantly influence body composition. Hence, together with determining alternative variables that allow comparison across different study groups, assessment of the appropriateness of using anthropometry prediction equations is another important issue in cross-ethnic, cross-cultural studies.

2.19.3 Knowledge gap in body image research

Due to the higher prevalence of health-related problems such as eating disorders, the vast majority of body image studies have been conducted on females. Consequently, even though there is an increase in the incidence of similar health problems among males, less information on their body image is available, to examine its impact as a causal factor. Also, many body image studies have been conducted from psychological and psychiatric perspectives, using a number of self-administering questionnaires and interviews; fewer studies, however, have incorporated physical body composition or body-size assessments. Consequently, in the field of kinanthropometry that aims to examine human functions through a detailed body composition assessment, the topic of body image remains as the area of limited knowledge. From the perspective of public health, it is important to assess how well individuals perceive their level of health risk in areas such as obesity and associated health problems such as diabetes and cardiovascular diseases. However, many previous body image studies only focused on the association between body image and mental and psychological problems—they did not consider increases in other health problems. Even studies that compared body image in relation to health problems used only a simple index, which is not necessary to assess subjects' responses in relation to body composition. Consequently, there is a need to assess individuals' body images in relation to their degree of health risk using detailed body composition assessment techniques. Furthermore, as there are only a small number of body image studies using Japanese males, there is a need to obtain further information on this specific group. This new information will allow international comparison of their body image responses and the impact of such responses on the risks of developing related health problems.

2.20 Summary

This chapter has reviewed the published literature on the topics of body composition and body image, in terms of their historical and theoretical backgrounds, associated public health problems, and methodologies for their assessment.

Body composition is important information to assess associations between the human body, lifestyle, and health risks. Many body composition assessment methods are based on assumptions of the body components (eg, density and hydration status of FFM) and require equations to predict body density or %BF of study groups. However, these assumptions vary with individuals and prediction equations are "population-specific". Consequently it is important to acknowledge these limitations in order to select appropriate body composition assessment method and prediction equations for the specific study samples.

A number of studies that assessed both body image in relation to the body composition to determine health problems including overweight and obesity is limiting. Many body image studies have been focused mainly on females and hence body image of males in relation to their body composition is a gap of knowledge. A distorted body image has been suggested to be in association with unhealthy weight-control behaviours, unusual muscle gaining behaviours (eg, excessive exercise and a use of anabolic steroid), and eating disorders. However, many body image studies examined body image of subjects without objective measures such as detailed body composition assessments. As %BF is an important indicator to assess health risk of individuals, assessment of body image in relation to a person's body composition may be important in prevention of body image related health problems.

Impacts of ethnicity and culture to body composition and a formation of body image have also explored. No reported studies that examined ethnic differences in body image, together with body composition and lifestyles variables that may be associated with a risk of developing health problems. There are also limited in a number of cross-ethnic studies that compared Asian male subjects with other ethnic counterparts. Body composition and body image studies that have focused on Japanese subjects were also reviewed. Japanese males have rarely been used in cross-ethnic studies to assess their body composition or body image. Further, there is no reported study comparing body image of Japanese males living overseas with Japanese males living in Japan or with other ethnic groups. To determine a change in health risks that may derive from a distorted body image, comprehensive assessments of lifestyle and body composition may be important.

Chapter 3 - Methodology

3.1 Study designs

Two separate studies were conducted to achieve the objectives of this study. The first study, a validation study, employed a cross-sectional design and a sample of Japanese and Australian Caucasian males. Its purpose was to assess the validity of body composition and body image assessing methods. The components included in the first study were shown below.

First study:

- Body image assessment using the Somatomorphic Matrix (SM) computer program
- Body composition assessments
  - Dual energy X-ray Absorptiometry (DXA)
  - Anthropometry

The second study, referred to as "the Main study", used a longitudinal design and aimed at determining the ethnic and cultural influences on body image among males, and the differences in their risks of developing health problems. The subjects in the longitudinal study were:

- Japanese males living in Australia
- Australian males living in Australia, and
- Japanese males living in Japan.

The study design of the second study was:

Second study:

- Baseline assessment by interview setting involving:
  - Body composition assessment using anthropometry
  - Lifestyle assessment using questionnaires and dietary record
  - Body image assessment using the SM program and questionnaires

- Three months follow-up by letters and e-mails including:
  - Lifestyle assessment using questionnaires and dietary record
  - Body image assessment using the SM program and questionnaires
- Six months follow-up by letters and e-mails including:
  - Lifestyle assessment using questionnaires and dietary record
  - Body image assessment using the SM program and questionnaires
- 12 months follow-up by interview setting including:
  - Body composition assessment using anthropometry
  - Lifestyle assessment using questionnaires and dietary record
  - Body image assessment using the SM program and questionnaires

Follow-up:

Follow-up assessments were conducted on Japanese and Australian Caucasian males living in their home countries over a period of three, six and twelve months. Follow-up was conducted through letters and e-mails for the first two follow-up sessions and face-to-face appointments were arranged for the last session. When letters were sent by post, a return pre-paid envelope or a stamped envelope was enclosed to improve the return rate.

The components included in each study session were as follows:

Baseline/Final assessments:	Demographic and lifestyle questionnaires; Dietary records; Body composition assessment; Body image assessment (by questionnaire); Body image assessment (by computer program);
First/Second follow-ups:	Demographic and lifestyle questionnaire; Body image assessment (by questionnaire); Self-reported body mass;

In addition to the abovementioned studies, the researcher has been collecting the body composition data of Japanese and Australian Caucasian males since Honours studies (Kagawa 1999), that is, for the period 1999 to 2003. It appears that this is the only available body composition database for Japanese males living in Australia. As data was collected by the same researcher according to the same protocol, the body composition datasets were pooled into one large database for analysis, referred to as the "All" database.

3.2 Subjects

Three groups were involved in this study:
1) Japanese males living in Australia (JA),
2) Australian males of Caucasian origin living in Australia (AA), and
3) Japanese males living in Japan (JA).

3.2.1 Inclusion/Exclusion Criteria

The baseline inclusion criteria were:
1) Male;
2) Aged between 18 and 40 years old;
3) In good health

In the current study "Japanese" were defined as those who met following criteria:
- Individuals who hold a Japanese passport;
- Individuals born of parents who are both Japanese;
- Individuals recognising themselves as "Asian".

Similarly, "Australian Caucasians" were defined as those who met the criteria listed below:
- Individuals holding an Australian passport;
- Born of parents of Caucasian origin i.e., not a mixed parentage, and
- Individuals recognising their racial background as "Caucasian", and not as "Asian", "Hispanic", "Black" or "Aboriginal/ Torres Strait Islanders"

Subjects were excluded if they were:

1) Female;
2) Outside the age range of 18 to 40 years old;
3) Suffering a chronic illness or physical impairment that would affect their body composition, lifestyle, and eating behaviour, for example Diabetes, or severe burns; and
4) Did not meet the specific criteria for being “Japanese” or “Australian Caucasian”.

3.2.2 Sample size

The Alpha level of 0.05, a standard deviation (SD) of 1.5, and a Power of 80% were used to calculate the sample size. For the “Validation” dataset a sample size of 45 per group (JA and AA) was calculated.

For the longitudinal study a sample size of 70 for those living in their home country (ie, JJ and AA), and a minimum of 30 Japanese living in Australia (JA), were calculated.

3.2.3 Recruitment methods

Recruitment of volunteers was conducted in Perth (Australia) and Himeji (Japan). Figure 3.1 shows the locations of Himeji and Perth.

Figure 3.1 Locations of data collection in a) Australia, and b) Japan
a) Location of Perth, Western Australia

b) Location of Himeji, Hyogo prefecture Japan

The recruitment of subjects in Australia was conducted in Perth, Western Australia. Recruitment was mainly conducted at the education institutions listed below (Table 3.1).

Table 3.1 List of institutions in Australia where visited to recruit subjects

Universities/Tertiary Institutions	Language School/Learning Institutions
-Curtin University of Technology -University of Western Australia -Metropolitan TAFE -Swan TAFE -Murdoch University	-Aspect ILA language school -Perth International College of English -Cambridge College -West Coast Language Academy -St. Mark's International College -Language Academy -Phoenix Language Academy -Adult Migrant Education Service -English Language Intensive Course for Overseas Students of Curtin University of Technology -Centre for English Learning Teaching of University of Western Australia

Approval from each institution was obtained prior to visits and direct contact with students was made. Recruitment was also conducted at facilities such as gymnasiums, community centres, Japanese food shops, restaurants, and also at the Japanese information centre.

In Japan, subjects were recruited at the Himeji Institute of Technology (Himeji, Hyogo Prefecture, Japan), the university having a research exchange contract with Curtin University.

During a recruitment process, contact details of potential subjects were obtained and later made an appointment with individuals for a detailed content of the study including distribution of written informed consent and screening questionnaire.

3.2.3.i) Number of subjects recruited

The table below shows the number of subjects recruited and measured for each dataset as well as the number of subjects included for analysis in each study topic (Table 3.2 and 3.3). The number of subjects used in analysis varied due to their not meeting the abovementioned inclusion criteria, incompletion of questionnaires or dietary records, and suspected over- or under- reporting of dietary intakes after estimation of their energy requirements. 51.5% of the 68 JA subjects used in the analysis of lifestyle and body image and 55.2% of 145 JA subjects included in the body composition analysis reported that they spend more than three months in Australia at the time of baseline assessment.

Table 3.2 Number of subjects in each database

Database	**Number of subjects recruited**		
	Japanese living in Japan (JJ)	Japanese living in Australia (JA)	Australian- Caucasians living in Australia (AA)
Validation	-	46	44
Main	96	69	78
All	-	145	143

Table 3.3 Number of subjects included in analysis of each study topic

Section of the Results Chapter reported	**Analysis topic**	**Number of subjects included in analyses**		
		JJ	**JA**	**AA**
Body composition	Body composition prediction equation	-	45	42
Body composition	Body composition	88	145	143
Lifestyle	Lifestyle	84	68	72
Lifestyle	Nutrient intake	81	65	70
Body image	Validation of SM computer program	-	45	42
Body image	Validation of body image questionnaires	84	68	72
Body image	Body image	84	68	72

Response rates for each follow-up session are shown in Table 3.4. The response rates for the first and second follow-up assessments were very low. The major factor causing low response rates, in particular for Japanese living in Japan, was the rejection of e-mails sent from a desktop computer, a choice that is made by the intended recipient. In the first follow-up, questionnaires were distributed via e-mail and participants were informed of the timeframe for the follow-up. However, a vast majority of Japanese in Japan exchange e-mails only through mobile phones, and to avoid so-called "junk" mails, e-mails from individuals whose name is not on their phonebook list are rejected. International calls were rejected in a similar manner, as Japanese mobile phones hide the phone number of the caller for all international calls. The second follow-up was therefore conducted using hard-copy letters, with return envelopes and Japanese stamps enclosed. However, a similar response rate resulted. According to the academic staff of Himeji Institute of Technology, this could be because subjects did not know how to return international mail, as for many of them it was probably the first time they had received international envelopes. Nonetheless, the only follow-up with an acceptable response rate was the final assessment, which obtained exactly the same components as the baseline. The response rates were calculated by subjects who have completed all assessments (ie, questionnaires, dietary record, and body composition assessments) in both baseline and final assessment sessions. The rates were 70.2% for Japanese living in Japan and 63.9% for Australian Caucasians.

Table 3.4 Response rates of the follow-up assessments

Study group	**Response rate**			
	First*	Second*	Final*	Applicable final response rate**
Japanese living in Japan	31/96 (32.3%)	32/96 (33.3)	61/96 (63.5%)	**59/84 (70.2%)**
Australian Caucasians living in Australia	35/78 (44.9%)	37/78 (47.4%)	48/78 (61.5%)	**46/72 (63.9%)**

$$\text{* Response rate} = \frac{\text{no. subjects who completed all assessments at the follow-up session}}{\text{no. subjects participated at the baseline session}} \times 100$$

$$\text{** Final response rate} = \frac{\text{no. subjects who completed all assessments at the final follow-up}}{\text{no. subjects completed all assessments at both baseline and the final assessments}} \times 100$$

In some cases the subjects were not available for follow-up assessments and so the number of responses differed slightly from the number given above. In the case of dietary analysis 58 Japanese living in Japan and 45 Australian Caucasian males were used after the assessment of under- or over-reporting (see section 3.3.5 of this chapter). 60 Japanese males living in Japan and 47 Australian Caucasian males were included in the analysis of topics that were not related with dietary intakes.

3.3 Instruments and Procedures

3.3.1 Somatomorphic Matrix Computer Program (SM)

The Somatomorphic Matrix computer program (SM) is a computer-based body image assessment program developed by Gruber, et al. (1998). It was developed from a body composition assessment using the anthropometry of 27 males and 39 females; each illustration was provided with body composition values that were represented as percent body fat (%BF) and the Fat Free Mass Index (FFMI). The program asks subjects to select the image that best represents their perceived current image, ideal image, and the male image which females desire most. The questions can be replaced or new questions can be added, according to the purpose of the research. In addition, the program asks questions concerning demographic information, levels of physical activity, degree of feeling fat and levels of body satisfaction.

The program was selected because of its potential in determining one's body image in relation to body composition. However, the validity of body composition values obtained from the SM program has never been examined; hence the current study first determined the validity of accepting body composition values as compared to the values obtained from the body composition measurements using duel energy x-ray absorptiometry (DXA). The SM program was used to determine the following points:

- Ethnic differences in general body image trends;
- Ethnic differences and the impact of environment upon body image, body perception and body acceptability in relation to body composition;
- Differences in body image in relation to risk of developing eating disorders and associated health risks.

To administer the program, subjects were asked to complete the questions asked in the program. For convenience of Japanese subjects, a sheet of translated instruction was provided. The instruction sheet was back translated and bilingual individuals who were not involved in the study confirmed the correctness of the translation. The program was completed approximately in 10minutes for all study groups.

3.3.2 Dual energy x-ray absorptiometry (DXA)

Dual energy x-ray absorptiometry (DXA; Hologic® QDR-2000, version 5.73) was used as the criterion for body composition assessment methods. A whole-body DXA scan was conducted at the Gairdner Bone Densitometry Services, Department of Endocrinology and Diabetes of Sir Charles Gairdner Hospital (Perth, Western Australia). Technicians of the Gairdner Bone Densitometry Services conducted all scanning. Each subject was asked to change their clothes to the required clinical clothing, and to remove any metals including earrings and watches, prior to the scan. While the scanning area was of a limited length and some individuals' height exceeded it, by bending their knees these individuals were able to fit within the scanning area. From the scan %BF, surface area, bone mineral content, bone mineral density, fat mass (FM), and lean body mass of the entire body and of particular body regions, such as the head, trunk and limbs, were obtained. The results obtained from QDR-2000 is believed to be accurate, though there is a known 9% systematic error in a conversion from Roentgens (exposure) to Gray (dose)

An entrance exposure and an effective dose using QDR-2000 were 1.2mR and 2.7μSv, respectively. Considering an effective dose of a typical chest x-ray ranged from 10-30μ Sv, the effective dose from the QDR-2000 will not cause significant damage to the human body.

3.3.3 Anthropometry

All subjects in the three data sets were measured according to the International Society for the Advancement of Kinanthropometry (ISAK) protocol (Norton et al. 1996). Measurement sites included eight skinfolds—triceps, subscapular, biceps, illiac crest, supraspinale, abdominal, front thigh, and medial calf; five girths—arm relaxed, arm flexed and tensed, waist, gluteal and calf; four bone breadths―biacromial, biiliocristal, humerus and femur; stretched stature and body mass. Definitions of measured sites are shown below (Norton et al. 1996):

Skinfold measured sites:

Triceps- A vertical fold at the marked mid-acromiale-radiale site on the most posterior surface of the arm over the triceps muscle when viewed from the side. Skinfold is raised with the left thumb and index finger. The arm of subject should be relaxed with the shoulder joint slightly externally rotated and elbow extended by the side of the body.

Subscapular- The thumb palpates the inferior angle of the scapula to determine the undermost top. The skinfold is raised with the left thumb and index finger at the marked site 2 cm along a line running laterally and obliquely downwards from the subscapular landmark at an angle (approximately 45°). The subject should be standing erect with the arms by the side.

Biceps- The fold is located on the most anterior aspect of the surface of the right arm when viewed from the side. The skinfold is raised with the left thumb and index finger on the marked mid-acromiale-radiale line so that the fold runs vertically i.e. parallel to the axis of the upper arm. The subject should stand with arm relaxed and the shoulder joint slightly externally rotated and elbow extended.

Iliac crest- The skinfold is raised immediately superior to the iliocristale on the ilio-axilla line. The subject abducts the right arm to the horizontal or places the arm across the chest to rest the right hand on the left shoulder. Align the fingers of the left hand on the iliocristale landmark and exert pressure inwards so that the fingers roll over the iliac crest. The fold runs slightly downwards toward the medical aspect of the body.

Supraspinale- Originally named suprailiac by Heath and Carter (1967). It is the skinfold used when the Heath-Carter somatotype is being determined. Fold is raised at the point where the line from the iliospinale mark to the anterior axillary border intersects with the horizontal line of the superior of the ilium at the level of the iliocristale. The fold runs medially downward at about a 45° angle.

Abdominal- A vertical fold raised 5 cm (approximately in the midline of the belly of the Rectus Abdominis) from the right hand side of the omphalion (midpoint of the navel).

Front thigh- The site is marked parallel to the long axis of the femur at the mid-point of the distance between the inguinal fold and the superior border of the patella (while the leg is bent). The subject's knee is bent at right angles by placing the right foot on a box or by being seated. The skinfold can be measured while the knee is bent of with the leg straight and resting on a box. If there is a difficulty in measuring skinfold of thigh, the subject may assist by lifting the underside of the thigh to relieve the tension of the skin. For a subject with very tight skinfold, a recorder can assist raising the fold.

Medial calf- With the subject either seated or with the foot on a box (knee at 90°) and with the calf relaxed, the vertical fold is raised on the medial aspect of the calf at a level where it has maximal circumference. View the marked site from the front to ensure the most medial point has been correctly identified.

Girths measured sites:

Arm relaxed- The girth of the upper arm (hanging in a relaxed position by the side of the body) is measured at the level of the mid-acromiale-radiale. The tape should be perpendicular to the long axis of the humerus.

Arm flexed and tensed- The maximum circumference of the right upper arm which is raised anteriorly to the horizontal with the forearm at about 45° to the upper arm.

Waist- The level of the narrowest point between the lower costal (rib) border and the iliac crest. If there is no obvious narrowing then the measurement is taken at the mid-point between these two landmarks. The measurement is taken at the end of a normal expiration with the arms relaxed at the sides.

Gluteal (hip)- The level of the greater posterior protuberance of the buttocks which usually corresponds anteriorly to about the level of the symphysis pubis. The subject stands with feet together and should not tense the gluteal muscles.

Calf- The maximum girth of the calf.

Bone breadths measured sites:

Biacromial- The distance between the most lateral points on the acromion processes. The site is measured with the arms of the large sliding callipers placed on the most lateral points of the acromion processes. The subject stands with the arms hanging at the sides, and the measurer, standing behind the subject, should bring the anthropometer blades n to the acromion processes at an angle of about 45° pointing upwards. Firm pressure should be applied to compress the overlying tissues.

Biiliocristal- The distance between the most lateral points (iliocristale) on the iliac tubercles is measured. The branches of the anthropometer are kept at bout 45° pointing upwards and the measurer stands in front of the subject. Firm pressure is applied by the anthropometrist to reduce the effect of overlying tissues.

Biepicondylar humerus- The distance between the medial and lateral epicondyles of the humerus was measured when the arm is raised anteriorly to the horizontal and the forearm is flexed at right angles to the upper arm. The small sliding caliper was placed directly on the epicondyles so that the arms of the calipers point toward at about 45° angle to the horizontal plane. Maintain firm pressure with the index fingers as the value is read.

Biepicondylar femur- The distance between the medial and lateral epicondyles of the femur was measured when the subject is seated and the leg flexed at the knee to form a right angle with the thigh. Place the caliper faces on the epicondyles so that the arms of the calipers point downward at about 45° angle to the horizontal. Maintain firm pressure with the index fingers until the value is read.

All subjects were measured using the same equipment throughout study. The following list identifies the measuring equipment used throughout the study:

Stature:	Stadiometer
Body mass:	Portable electronic weighing scale
Skinfold measurements:	Harpenden skinfold caliper
Girths measurements:	Anthropometry tape
Bone breadth measurement:	Sliding calipers (small and large)

(Norton et al. 1996)

Figure 3.2 and 3.3 show equipments used in anthropometry.

Figure 3.2 Harpenden skinfold caliper

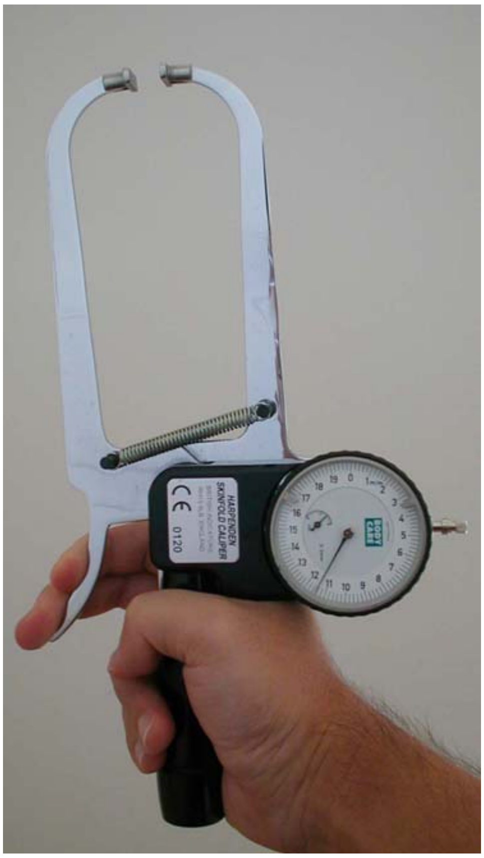


Figure 3.3 The "Centurian" anthropometry kit (Rosscraft®) used in body composition assessment

The portable electronic weighing scale was calibrated before every session using standard weights. Subjects were asked to wear light clothing such as a T-shirt and shorts. The measurement sites were marked by a level three (instructor) anthropometrist accredited by ISAK, prior to the measurement. All subjects were measured by either a level three or level one (restricted profile) anthropometrist, accredited by ISAK. Duplicate measurements were taken from all sites and a third measurement was taken if a difference between the first and second measurements was observed. Differences greater than 0.5mm for skinfolds and 0.5cm for girths i.e., >0.5 were the 'benchmark' for a third measurement.

From the measurements, the Body Mass Index (BMI), Waist-to-Hip Ratio (WHR), %BF, corrected arm- and calf-girths, height-corrected sum of eight skinfolds, and somatotype, were calculated. In order to determine the best combination of body density and %BF prediction equations, several different equations were compared with the results obtained from the DXA scan in the first stage of the body composition assessments. Equations used in the body composition assessments are listed below (Table 3.5):

Table 3.5 Equations used to calculated anthropometric variables

Variable	Equation	Note
Body Mass Index (BMI)	BMI = body mass (kg)/stature^2 (m)	
Waist-to-Hip Ratio (WHR)	WHR = waist girth (cm)/gluteal girth (cm)	
Corrected girths	Corrected girths = C – π*S	C = Circumference S = Skinfolds
Height-corrected sum of skinfolds	Height-corrected skinfolds = X_1*(170.18/Stature)	X_1 (mm) = Sum 8 skinfolds[#]
Body Density (BD) (Durnin and Womersley, 1974)	BD = 1.1765 – 0.0744*($\log_{10} X_1$)	X_1 (mm) = Sum 4 skinfolds[###]
Body Density (BD) (Withers, et al. 1987)	BD = 1.0987 – 0.0004*(X_1)	X_1 (mm) = Sum 7 skinfolds[##]
Body Density (BD) (Nagamine and Suzuki, 1964a)	BD = 1.0913 – 0.00116* (triceps + subscapular)	
Body Density (BD) (Nagamine and Suzuki, 1964b)	BD = 1.0863 – 0.00176*(abdominal)	
Percent Body Fat (%BF) (Siri, 1961)	%BF = 495/BD – 450	BD = Body Density
Percent Body Fat (%BF) (Brozek, et al. 1963)	%BF = (4.57/BD – 4.142)*100	BD = Body Density
Fat Free Mass Index (FFMI)	FFMI = body mass*(100 – %BF)/100+6.1*(1.8-stature)/stature^2	%BF = total body fatness
Fat Mass (kg)	FM = %BF*body mass	%BF = total body fatness
Fat Free Mass (kg)	FFM = body mass – FM	FM = fat mass

[#] Sum of 8 = triceps, biceps, subscapular, iliac crest, supraspinale, abdominal, front thigh and mid calf in mm.
[##] Sum of 7 = triceps, subscapular, biceps, supraspinale, abdominal, front thigh and med calf in mm.
[###] Sum of 4 = triceps, biceps, subscapular, and iliac crest in mm.

From the finding of the current study, body fatness using anthropometry was determined by a combination of ‘Durnin and Womersley’ body density prediction equation and Siri’s body fat prediction equation.

Somatotype was determined based on the Heath and Carter method. In this method a numerical value is given to each of the three types of body characteristic. The three characteristics involved with a construction of person's physique are;

1) Endmorphy (relative fatness),
2) Mesomorphy (relative muscularity), and
3) Ectomorphy (relative linearity) (Carter & Heath 1990)

The Lifesize® program (version 2.0, 1994, Nolds Sports Scientific) was used for somatotype calculations.

To define a cut-off point of overweight of males, percent body fat (%BF) of 20 was selected (Table 3.6). This value is consistent with the cut-off point recommend in both Japanese and Western literature for overweight and for optimal fitness (Nagamine 1972; Wilmore et al. 1986). In addition, the Japan Society of the Study of Obesity (JASSO) also used %BF of 20 as the cut-off point for the diagnosis of obesity (Fukunaga 2003 personal communication).

Table 3.6 Cut-off points of overweight and obese for adult males using percent body fatness (%BF)

	Thin	**Normal**	**Overweight**	**Obesity**
Nagamine (1972)	<10	10≤ - <20	20≤ - <25	25≤
Wilmore, et al. (1986)	<12	12≤ - <18	18≤ - <25	25≤

(Adopted and modified from Nagamine, 1972; Wilmore, et al., 1986)

3.3.4 Questionnaires

Questionnaires to determine living conditions, lifestyle factors including eating behaviours and frequency of physical activity, body image, and the risk of developing eating disorders were administered to subjects in the main study.

a) Living conditions and lifestyle questionnaires

Questions on living conditions and lifestyle were adopted and modified from the previously developed and validated questionnaires of the Australian National Nutrition Survey, the Japanese National Nutrition Survey (JNNS), and the Hawaii' Cancer Research Survey.

b) Body image questionnaires

In addition to the Somatomorphic Matrix computer program (SM), behaviours and attitudes that are thought to be associated with distorted body images were assessed using the Ben-Tovim Walker Body Attitude Questionnaire (BAQ), and the Attention to Body Shape Scale (ABS).

The BAQ is a 44-item self-administered questionnaire designed to assess a broad range of attitudes that individuals hold towards their bodies. The attitudes which the BAQ examines are 1) Feeling fat, 2) Self-disparagement, 3) Strength, 4) Salience, 5) Attractiveness, and 6) Lower body fatness. From the results of 504 female respondents, a high internal-consistency of 0.87, a high correlation coefficient of 0.92, satisfactory test-retest reliability for the total score ($r = 0.83$) and for each subscale, and good convergent validity with existing instruments were demonstrated (Ben-Tovim & Walker 1991). Although it has been administered to neither males nor Japanese subjects, the BAQ was used to determine any ethnic differences in attitudes that are assumed to be associated with body image formation.

The ABS places more emphasis on the degree of body focus, that is, the amount of effort individuals exert to improve their body appearance. From a study using 22 males and 49 females, the ABS showed relatively high internal-consistency (between 0.7-0.82) and acceptable two-week test-retest reliability ($r = 0.76$ for females and $r = 0.87$ for males). In addition, the ABS showed correlation that was significant with results obtained from the EAT-26 ($p<0.001$) using females subjects (Beebe 1995).

Furthermore, subjects were also asked how often they compared themselves with others on the street and with those in the media. To determine detailed information on body image, as well as their perceptions of their own body weights and body fatness, subjects were asked about their ideal weight in relation to their current stature.

c) Risk of developing eating disorders

The 26-item Eating Attitudes Test (EAT-26; EAT) was administered to determine the future risk of developing eating disorders, as suggested body-image related disorders. The EAT is a questionnaire developed by Garner and Garfinkel (1979) to assess the likelihood of an individual having an eating disorder. The EAT has widely been used in many countries as a screening tool for disordered eating behaviours (Nasser 1994; le Grange, Telch & Tribbs 1998; Stephens, Schumaker & Sibiya 1999). The original version consists of 40 questions, but later a 26-item version was developed (Garner et al. 1982). EAT-26 considers three factors: 1) Dieting, 2) Bulimia and food preoccupation, and 3) Oral control. EAT-26 is highly correlated with the original EAT as a whole (r = 0.98), as well as with each subscale (Dieting: r = 0.93, Bulimia: r = 0.64, and Oral control: r = 0.64). The criterion-related validity of EAT-26 as a screening tool for eating disorders has been displayed and also its reliability was stated by the previous study (Garner et al. 1982). EAT-26 has been translated into Japanese. The validity of the Japanese version has been confirmed (Higashi et al. 1984; Suematsu et al. 1984) and it has been frequently used in previous studies (Tsutsui et al. 1994; Watanabe 1996; Nakamura et al. 1999). As the majority of subjects in this study were expected to be non-eating-disordered, the six-points scoring method proposed by Wells, et al. (1985) was adopted to avoid a skewed distribution of results. This scoring method allows a precise comparison to be made of differences in the level of disordered eating between subjects.

In addition, the Suinn-Lew Asian Self-Identity Acculturation Scale (SL-ASIA) was administered to Japanese subjects in order to take a level of acculturation into account for the differences in their lifestyles and body image responses. The SL-ASIA originally consisted of 21 items to assess the topics of 1) Language, 2) Identity, 3) Friendships, 4) Behaviours, 5) Generational and geographical background, and 6) Attitudes. From a sample of 28 males and 54 females, an internal-consistency of 0.88 was obtained. In addition, based on use with five different generations living in the US (total = 59), the questionnaire has been suggested as being sufficient to assess acculturation levels of those who are from non-Western backgrounds (Suinn et al. 1987). Later data from 284 Asian-American university students produced a Cronbach alpha of 0.91 and concurrent validity which suggests SL-ASLA is sufficient to measure levels of acculturation (Suinn, Ahuna & Khoo 1992). The SL-ASIA later included 5 additional questions, meaning it consists of 26 items. In the current study 17 of these questions, which were thought to be appropriate, were adopted and administered.

Formal approvals were obtained from the researchers who own the copyrights for these instruments prior to administration. All questionnaires were then prepared in two languages— Japanese and English. Each question was back-translated until the equivalent meaning of the original question was achieved. Translated questionnaires were also checked by two bilingual individuals for confirmation, one of whom is an accredited translator.

3.3.5 Dietary analysis

The four-days diet record was used to determine the daily nutrient intakes of subjects. Every subject was asked to record everything they had consumed, including water, for four days. All subjects were also asked to include at least one weekend in the record. The record was distributed as a booklet containing complete instructions, an example of a completed diary, and also a set of photographs to assist subjects in estimating serving sizes. In order to prepare photographs of Japanese foods, several pictures from the "Sonomanma ryouri cards" (meal planning real-size cards), which were developed and edited by Adachi (1994, Tokyo), were adopted and scanned into the dietary record booklet. Each card is usually presented life-size and contains the amount of ingredients in each meal. However to allow subjects to compare the sizes of each meal in the booklet, all pictures were decreased to 25% of their real size. To provide a reference to real dish sizes, pictures of spoons and chopsticks, which were also diminished into 25% of their real size, were also included.

In prior to analysis, a presence of under- and over-reporters were examined. Over-reporters were defined as consumption of energy more than 1.6MJ/day. One Japanese subject was classified as an over-reporter and hence was removed. To determine under-reporters, the basal metabolic rate (BMR) of subjects was calculated by the Harris Benedict equation:

$$\text{Men} = 278 + (57.5 \times W) + (20.9 \times H) - (28.3 \times A) \text{ kJ/day}$$

Where: W = Body mass in kg

H = Stature in cm

A = Age in years

The equation has been accepted as a standard for nutritional and metabolism assessments (Frankenfield, Muth & Rowe 1998). With acknowledgement of its limitations, Frankfield, et al. (1998) concluded in the review of the original study conducted in 1919 and later additional studies that, methodologies and conclusions made by Harris and Benedict were valid and reasonable.

The values were then multiplied by 0.88 according to the Goldberg critical evaluation of energy intake data using 99.7% confidence interval (Goldberg et al. 1991). From the calculation, two Australian males and seven Japanese males were classified as under-reporters. However it is possible that they are not under-reporting but simply eating insufficiently. A removal from the database was considered based on their questionnaire responses, such as signs of changes in weight and a frequency and intensity of exercise levels.

Dietary information obtained from the record was entered into two computer-based nutrition analysis programs according to the country the information was obtained from. Food Works® Professional Edition (Version 3.01.472, 2003, Xyris Software, Brisbane) was used for subjects recruited in Australia, while Eiyo-kun® (Version 3.01, 2001, Kenpakusha) was used for Japanese who provided their data in Japan. The rationale for using different software programs was to overcome the problem of food products that are not available in one or other country. Using programs developed in each country also allowed for the consideration of differences in the nutritional content of food products, potentially caused by differences in soil and farming methods. All data was entered to obtain an average nutrient intake for the four days.

3.4 Ethical considerations

The study was approved by the Human Research Ethics Committee of Curtin University of Technology. An information sheet that fully explained details of the study was given to all subjects. They were asked to read this information and to give their written informed consent prior to their involvement in the study. The written informed consent included the aims, significance, and methods of the study, as well as notification of the confidentiality of obtained data and a written record that any subject could choose to withdraw from the study at any time without prejudice.

In addition to the above content, the involvement of radiation and its potential impact upon subjects' health was fully explained in the section of the study involving a whole-body DXA. To subjects who were involved in follow-up studies, involvement in the repeated assessments was explained.

3.5 Statistical analyses

Microsoft Excel was used to calculate technical error of measurement (TEM) in the anthropometry method. TEM is defined as the standard deviation of repeated measurements taken independently of one another on the same subject (Pederson & Gore 1996). To simplify the comparison of TEMs collected on different variables, conversion of the absolute TEM to a relative TEM (%TEM) was conducted. The formula for this calculation is:

$$\%TEM = TEM/Mean \times 100$$

Where:

Mean = the overall mean of the variable

(Pederson & Gore 1996)

TEM, and %TEM were calculated for first two sets of subjects' anthropometry measurements. Table 3.7 showed %TEM results using 20 randomly selected subjects from the "All" dataset, which included all subjects obtained from both the validation and the main studies. All measures cited were within the target TEM for level three anthropometrists suggested by ISAK; that is, below 5% for skinfolds and below 1% for other measurements (Gore et al. 1996).

SPSS for Windows (version 10.0, 1999, Chicago) was used for other statistical analyses. The following tests were conducted:

- Limit of Agreement
- Independent t-test

- Paired t-test
- Weighted Kappa test
- Sensitivity/specificity
- Chi-squared test
- Multiple regression analysis

Table 3.7 Percent Technical Error of Measurements (%TEM) from anthropometry

		Japanese Males living in Japan (%)	Japanese Males living in Australia (%)	Australian Males living in Australia (%)
Skinfolds	Triceps	1.35	1.48	1.91
	Subscapular	1.56	1.64	1.66
	Biceps	2.77	3.69	3.86
	Iliac Crest	2.19	2.02	2.92
	Supraspinale	1.85	1.50	2.40
	Abdominal	1.54	2.16	1.02
	Front Thigh	3.90	1.79	1.17
	Medial Calf	2.17	1.68	1.75
Girths	Arm (relaxed)	0.47	0.41	0.52
	Arm (flexed and tensed)	0.44	0.48	0.44
	Waist	0.31	0.26	0.26
	Gluteal	0.31	0.51	0.15
	Calf	0.37	0.32	0.32
Bone breadths	Biacromial	0.37	0.47	0.57
	Biiliocristal	0.34	0.24	0.44
	Humerus	0.76	0.34	0.61
	Femur	0.16	0.28	0.42

Chapter 4 - Results

Contents of this chapter are as follow:

Part I. Body composition

4.1.1 Introduction

Anthropometric equations for the prediction of percent body fat are population specific, and can only be applied to a population similar to that used for their development. For Japanese adult males, there is one equation that has been developed from anthropometry and widely accepted in Japanese studies (Nagamine & Suzuki 1964). However, this equation was developed 40 years ago and because of the secular trend in growth there is an uncertainty about the validity of this equation for Japanese males living today. Since World War II, there has been rapid increase in stature, body mass and BMI of Japanese. This may mean that there is a need for the development of new body composition prediction equations for Japanese males. The purpose of this study was to test existing equations and develop new prediction equations for the estimation of percent body fat in Japanese and Australian Caucasian males using dual energy x-ray absorptiometry (DXA) as the criterion method. The study was conducted using Japanese and Australian Caucasian males living in Perth (Western Australia).

This section also examined ethnic differences in body composition, including relationships between the body mass index (BMI) and percent body fat (%BF), using data from a larger sample of Japanese and Australian Caucasian males. The BMI is in widespread use around the world as an indicator of fatness and to clinically assess obesity. This wide acceptance has been due to its simplicity and high specificity in screening for total body fatness (%Body Fat; %BF) (Garrow & Webster 1985; Roche 1996). However a number of studies have indicated limitations in its use. The BMI is influenced by leg length in relation to the stature. It is also unable to distinguish between fat and lean body mass (Norgan & Ferro-Luzzi 1982; Garn, Leonard & Hawthorne 1986; Ross et al. 1988). Recent reports have shown that Asians possess greater %BF at any given BMI values (WHO/IASO/IOTF 2000; Deurenberg, Deurenberg-Yap & Guricci 2002; WHO 2004). As a result, Japanese and other Asians may be at risk of developing various health problems such as diabetes and coronary heart diseases at lower BMI values than Caucasians. From the finding of this study, the most effective BMI cut-off points for use as a screening tool for overweight and obesity for Japanese and Australian Caucasian males will be proposed. The details of the subjects used for this study and the body composition assessment methods were described in the methodology chapter (Chapter Three).

4.1.2 Applicability of Japanese-specific body density equations to Japanese males living overseas: Comparison of anthropometry and DXA results

No studies have been reported on the body composition of Japanese males living in Australia and on appropriate body density and body fat prediction equations for use in this population. In order to determine appropriate prediction equations for Japanese males, Japanese males living in Australia were recruited and their body composition was assessed using anthropometric methods. The results from the anthropometric studies were then compared with the data obtained when body composition was assessed using the DXA. The body composition data of Japanese males living in Australia was also compared with that of Australian Caucasian males.

Physical characteristics of the subjects are shown in Table 4.1.1. Australians were significantly ($p<0.05$) taller (11.5cms), heavier (12kgs), and had greater total bone density than Japanese males. Australians had significantly greater amount of lean body mass than Japanese males, but there was no difference in total fat mass or percent body fat (%BF) between groups. The somatotypes of the two groups were also similar (Japanese: 2.7-4.6-3.1, Australian: 2.7-5.0-2.8) (see section 3.3.3 of Methodology Chapter for an explanation of somatotype).

Table 4.1.1 Physical characteristics of the study group

	Japanese (n =45) Mean ± SD	Australian (n =42) Mean ± SD
Age (Years)	24.29 ± 5.48	22.62 ± 5.32
Stature (cm)	171.57 ± 5.79	180.08 ± 7.86*
Body mass (kg)	62.61 ± 9.62	74.50 ± 9.60*
Body Mass Index (kg/m^2)	21.28 ± 2.31	22.95 ± 2.54*
Waist Hip Ratio (WHR)	0.81 ± 0.04	0.81 ± 0.04
Fat mass by DXA (g)	9961.3 ± 4379.6	12163.6 ± 6047.6
Lean body mass by DXA (g)	52144.5 ± 4661.4	62022.9 ± 6143.3*
Total Bone Density (g/cm^2)	1.10 ± 0.08	1.17 ± 0.09*
% Body Fat by DXA (%BF) (%)	15.70 ± 5.61	15.87 ± 6.19
Somatotype	2.7-4.6-3.1	2.7-5.0-2.8

* Significant at the 0.05 level.

The results obtained from the DXA scan and predicted body fat values from various anthropometric equations were compared (Table 4.1.2). Significant (p<0.05) differences were present between values obtained from the DXA and predicted values using anthropometry. Application of the 'Durnin and Womersley' body density equation (1974) with Siri's body fat prediction equation (1963) was the only combination that predicted body fat values equivalent to the values obtained from the DXA scan for Australian males.

For Japanese males, application of the 'Durnin and Womersley' or the 'Nagamine and Suzuki (b)' body density equations (1964) yielded total body fat values that were similar to the DXA results. In comparison with the DXA results, combinations using the 'Nagamine and Suzuki (a)' (1964) and the 'Withers, et al.' (1987) body density prediction equations gave significantly (p<0.05) lower body fat values for both Japanese and Australian subjects. In addition, the 'Nagamine and Suzuki (a)' and the 'Withers, et al.' equations paired with Brozek's body fat prediction equation estimated significantly (p<0.05) larger body fat than those used the Siri's equation.

Table 4.1.2 Differences between DXA result and predicted values obtained from different combinations of body density and percent body fat prediction equations#

Combinations of body density and body fat prediction equations		Japanese (n =45)		Australian (n =42)	
		Mean ± SD (r ± SEE)	**% Difference**	**Mean ± SD (r ± SEE)**	**% Difference**
%BF from DXA scan		15.70 ± 5.61		15.87 ± 6.19	
Durnin and Womersley	Siri	15.70 ± 4.64 (0.85 ± 2.97)	$-6.5*10^{-4}$ ± 2.94	16.04 ± 4.95 (0.87 ± 3.04)	-0.2 ± 3.04
	Brozek	15.75 ± 4.29 (0.85 ± 2.97)	$-5.0*10^{-2}$ ± 2.98	16.06 ± 4.57 (0.87 ± 3.04)	-0.2 ± 3.12
Withers, et al.**	Siri	10.94 ± 3.99* (0.78 ± 3.57)	4.8 ± 3.54	12.49 ± 5.00* (0.92 ± 2.42)	3.4 ± 2.49
	Brozek	11.35 ± 3.69* (0.78 ± 3.57)	4.3 ± 3.59	12.78 ± 4.62* (0.92 ± 2.42)	3.1 ± 2.63
Nagamine and Suzuki (a)**	Siri	13.34 ± 3.08* (0.83 ± 3.19)	2.4 ± 3.52	13.35 ±3.64* (0.88 ± 2.97)	2.5 ± 3.45
	Brozek	13.57 ± 2.84* (0.83 ± 3.19)	2.1 ± 3.63	13.58 ± 3.36* (0.88 ± 2.97)	2.3 ± 3.60
Nagamine and Suzuki (b)	Siri	15.43 ± 6.03 (0.85 ± 3.03)	0.3 ± 3.26	18.14 ± 7.39* (0.88 ± 3.00)	-2.3 ± 3.55
	Brozek	15.50 ± 5.57 (0.85 ± 3.03)	0.2 ± 3.11	18.00 ± 6.83* (0.88 ± 3.00)	-2.1 ± 3.27

* Significant difference with DXA value at the 0.05 level.
** Significant difference between estimated values using Brozek and Siri equations at the 0.05 level.
# All equations are listed in methodology section

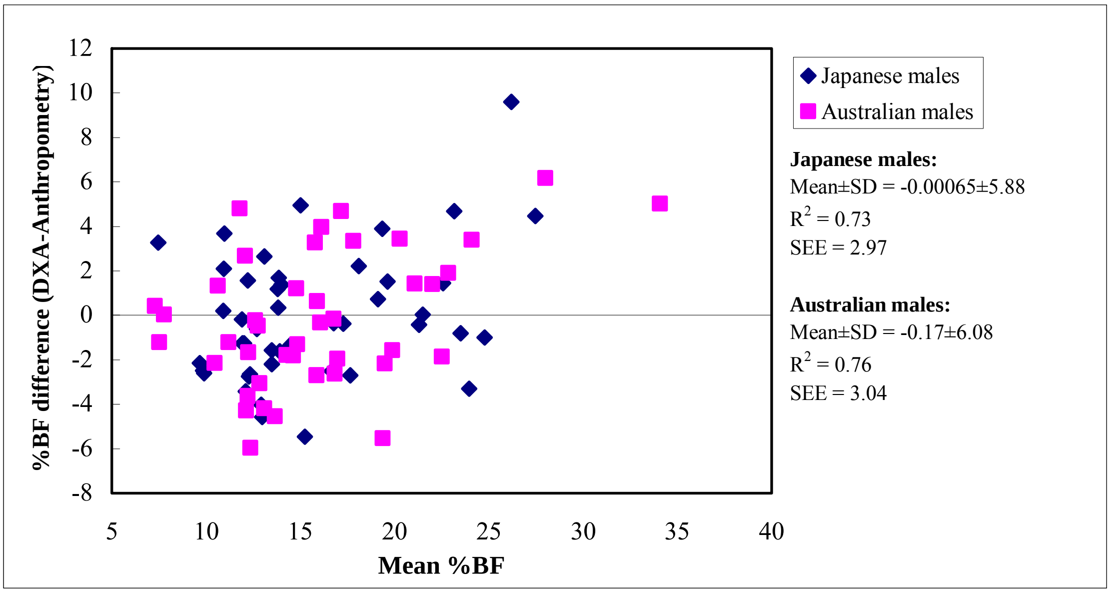
In addition to a mean difference, the intra-variability between the values obtained from the DXA scan and anthropometry was examined using the limits of agreement method (Bland & Altman 1986) (Table 4.1.3). Among the combinations of body density and body fat prediction equations, the combination of the 'Durnin and Womersley' body density equation and Siri's body fat prediction equation showed a mean value of $-6.5*10^{-4}$ with a standard deviation of 5.88 for Japanese living in Australia and a mean of -0.17 with a standard deviation of 6.08 for Australian Caucasian males respectively. The predicted %BF obtained when using combinations that included the 'Withers, et al.' body density equation showed greater differences in obtained body fat values in comparison to the DXA result than the other equations that were tested, regardless of ethnicity. (Table 4.1.3) Two equations developed by Nagamine and Suzuki were also examined in this study; the equation using the sum of two skinfolds (triceps and subscapular), and the equation using only the abdominal skindold. The equation using the sum of two skinfolds (ie, 'Nagamine and Suzuki (a)') showed a pattern of increasing underestimation of %BF as the %BF obtained by the DXA scan increased. In comparison, the equation using the abdominal skinfold (ie, 'Nagamine and Suzuki (b)') yielded a value for the %BF closer to the %BF value from the DXA results. However this equation also showed a trend of increasing underestimation of %BF as the %BF (DXA) increased.

For Australian males, both equations by Nagamine and Suzuki tended to underestimate their body fatness, and the degree of underestimation increased as the body fat as measured by the DXA increased. The results of the limits of agreement calculation for the 'Durnin and Womersley' and the 'Nagamine and Suzuki (a)' are presented in Figure 4.1.1 and 4.1.2.

Table 4.1.3 The limits of agreement between the DXA results and combinations of body density and percent body fat prediction equations

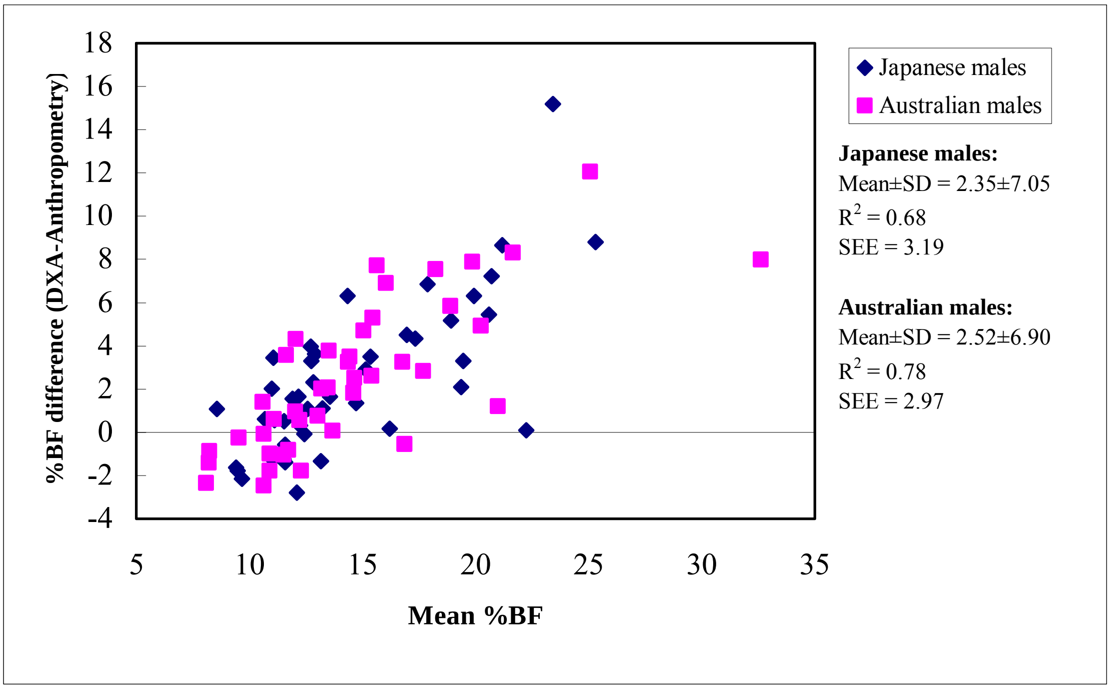
Combinations of equations	Japanese (n = 45)	Australian (n = 42)
DXA & Durin and Womersley (Siri)	-0.00065 ± 5.88 (-5.88, 5.88)	-0.17 ± 6.08 (-6.25, 5.91)
DXA & Durnin and Womersley (Brozek)	-0.05023 ± 5.96 (-6.01, 5.91)	-0.20 ± 6.25 (-6.44, 6.05)
DXA & Withers (Siri)	4.76 ± 7.90 (-2.33, 11.85)	3.38 ± 4.98 (-1.60, 8.37)
DXA & Withers (Brozek)	4.34 ± 7.18 (-2.84, 11.52)	3.09 ± 5.25 (-2.17, 8.34)
DXA & Nagamine (a) (Siri)	2.35 ± 7.05 (-4.69, 9.39)	2.52 ± 6.90 (-4.38, 9.42)
DXA & Nagamine (a) (Brozek)	2.12 ± 7.27 (-5.15, 9.39)	2.29 ± 7.21 (-4.92, 9.50)
DXA & Nagamine (b) (Siri)	0.26 ± 6.52 (-6.26, 6.78)	-2.27 ± 7.10 (-9.37, 4.83)
DXA & Nagamine (b) (Brozek)	0.19 ± 6.22 (-6.02, 6.41)	-2.13 ± 6.55 (-8.68, 4.42)

Figure 4.1.1 Intra-differences in %BF measured by DXA and Anthropometry*



* %BF from anthropometry was predicted using a combination of Durnin and Womersley body density prediction equation (1974) and %BF prediction equation by Siri (1963).

Figure 4.1.2 Intra-differences in %BF measured by DXA and Anthropometry*



* %BF from anthropometry was predicted using a combination of Nagamine and Suzuki body density prediction equation (1964) and %BF prediction equation by Siri (1963).

In order to determine body fat prediction equations using anthropometric variables, stepwise multiple regression analyses were conducted using the following variables:

Independent variables-

1) Individual skinfold sites,
2) 'Sum of 7 skinfolds',
3) 'Sum of 8 skinfolds', and
4) 'Height-corrected sum of 8 skinfolds', and
5) Age

Dependent variable-

1) Percent body fat from the DXA scan

Results are shown in Table 4.1.4. Both ethnic groups showed correlations of 0.7 to 0.8 for each proposed equation. The strongest correlations were observed from the equation that using individual skinfold sites (Japanese: $r^2 = 0.786$ using abdominal, medial calf, and age; Australians: $r^2 = 0.864$ using medical calf, supraspinale, and triceps skinfolds). Correlation between the DXA results and the height-corrected sum of 8 skinfolds were 0.708 (SEE = 3.10) for Japanese males and 0.824 (SEE = 2.63) for Australian Caucasian males respectively. Correlations were lower than the models using the sum of 8 skinfolds for each ethnic group. The presence of ethnic differences in body fat prediction equation was also examined. After including a 'group' variable in addition to variables listed above, no significant difference was obtained for prediction equations using each skinfold sites and the height-corrected sum of 8 skinfolds.

Table 4.1.4 Regression equations# developed from DXA scan and anthropometry assessment

		Regression equation	R^2	SEE
Japanese	**Skinfold sites**	y = 0.376 + 0.402(abdominal) + 0.772(medial calf) + 0.217(age)	0.786	2.691
	Sum 7	$y = -1.888 + 0.165\Sigma X_1 + 0.304(age)$	0.685	3.224
	Sum 8	$y = -1.268 + 0.142\Sigma X_2 + 0.270(age)$	0.714	3.071
	Ht-corrected sum 8	$y = -0.544 + 0.142Ht\Sigma X_2 + 0.248(age)$	0.708	3.104
Australian	**Skinfold sites**	y = 2.184 + 0.392(medial calf) + 0.678(supraspinale) + 0.467(triceps)	0.864	2.373
	Sum 7	$y = 1.751 + 0.200\Sigma X_1$	0.850	2.431
	Sum 8	$y = 2.138 + 0.165\Sigma X_2$	0.847	2.449
	Ht-corrected sum 8	$y = 2.397 + 0.172Ht\Sigma X_2$	0.824	2.626
Both	**Skinfold sites**	y = 4.842 + 0.276(abdominal) + 0.704(triceps) + 0.315(iliac crest) – 0.850(biceps)	0.802	2.670
	Ht-corrected sum 8	$y = 3.301 + 0.165Ht\Sigma X_2$	0.742	2.996

Where ΣX_1 = Sum of 7 skinfolds (triceps, subscapular, biceps, supraspinale, abdominal, front thigh, medical calf in mm), ΣX_2 = Sum of 8 skinfolds (triceps, subscapular, biceps, iliac crest, supraspinale, abdominal, front thigh, medical calf in mm), $Ht\Sigma X_2$ = Height-corrected sum of 8 skinfolds, and SEE = Standard error of estimate

In this study the %BF values of both Japanese and Australian Caucasian males were obtained from DXA and anthropometry and have been compared. The studies on both ethnic groups showed a better predictability of their %BF using the Durnin and

Womersley equation. The patterns of underestimation of %BF using the Nagamine and Suzuki equation (Figure 4.1.2) were the same for both ethnic groups. These results may indicate that the physique of Japanese males has altered since the Nagamine and Suzuki equations were first proposed. The results may also indicate that Japanese have become more Western-like in their physique and that as a result it may be possible to predict BF using equations developed in the West.

4.1.3 Ethnic differences in body composition and the BMI-%BF relationship

The results given in section 4.1.1 showed that 'Durnin and Womersley' body density prediction equation is the best equation of those examined, to be used to estimate %BF of both Japanese and Australian males living in Australia. Based on the finding (see section 4.1.1 of this chapter), the 'Durnin and Womersley' body density prediction equation have the highest level of agreement with DXA and is therefore used to determine %BF of both Japanese and Australian Caucasian males in the research reported in the rest of the thesis.

In the previous section a sample of n = 45 (Japanese) and n = 42 (Australians) was used. In this section a larger sample of Japanese (JA = 145) and Australian Caucasian males living in Australia (AA = 143) as well as Japanese males living in Japan (JJ = 88), were used to study body composition and its relationship with the BMI. As Table 4.1.5 shows, the age of Japanese living in Japan was younger than other groups, by two to three years ($p<0.05$). Using anthropometry, the differences described in section 4.1.1, were also observed in these groups. As can be seen in results (Table 4.1.1), there were ethnic differences in body size, including stature and body mass ($p<0.05$). The Australians had a significantly greater sum of skinfolds than Japanese groups ($p<0.05$), but after the results were adjusted for height, no significant differences remained. This indicates that in terms of proportionality (ie, after the results were adjusted for height), there were no differences in the amount of subcutaneous fat deposits between the two ethnic groups.

However, the corrected girths and somatotype showed that Australian males were more muscular than Japanese ($p<0.05$). In addition, the JJ groups had significantly smaller values for the waist-to-hip ratio (WHR) than the AA. There were no significant differences in waist and gluteal girths between JA and JJ (Appendix Seven)

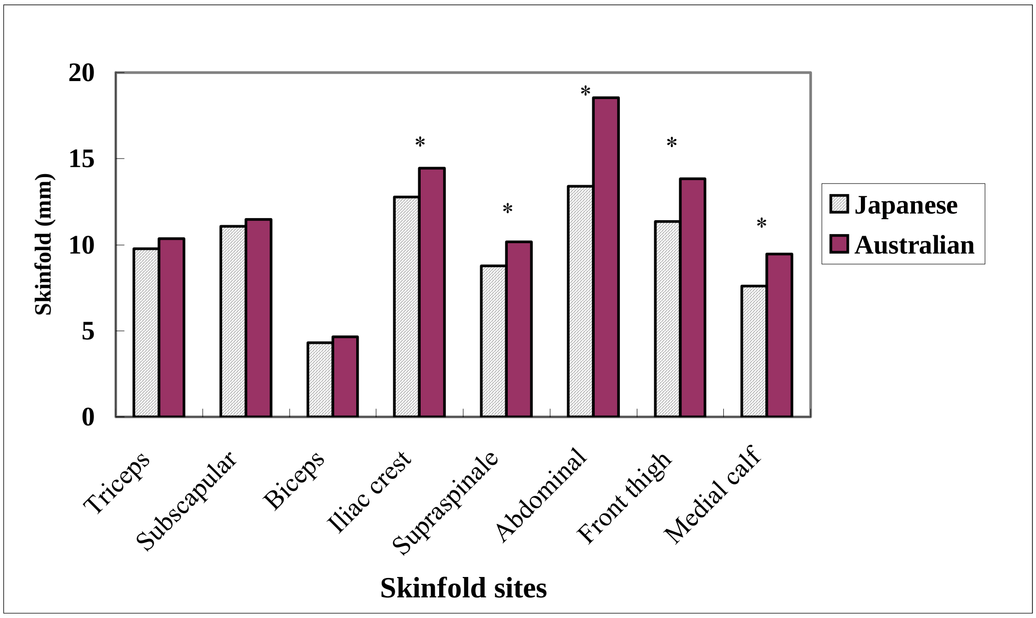
As no significant differences were observed, the JJ and JA group were combined into one group (n = 233) for further analysis of the ethnic differences in body composition. Using the combined Japanese group compared to the Australian group, ethnic differences in subcutaneous fat distribution and girths values were determined (Figure 4.1.3 and 4.1.4). Figure 4.1.3 shows that Australian males have significantly ($p<0.05$) greater subcutaneous fat on their trunk and lower body than their Japanese counterparts. Figure 4.1.4 confirmed that Australians have greater girths than Japanese males and similarly, Australian males had significantly greater bone breadths than Japanese males (Appendix Seven).

Table 4.1.5 Results of body composition assessment obtained by anthropometry

	JA (n =145) Mean ± SD	JJ (n =88) Mean ± SD	AA (n =143) Mean ± SD
Age (Years)	23.3 ± 4.0	20.5 ± 1.6*	22.3 ± 4.0**
Stature (cm)	171.5 ± 5.3	172.9 ± 5.3	180.9 ± 7.9*, **
Body mass (kg)	64.2 ± 8.8	64.1 ± 8.9	77.2 ± 11.4*, **
Body Mass Index (kg/m^2)	21.8 ± 2.6	21.5 ± 2.8	23.5 ± 2.9*, **
Waist Hip Ratio (WHR)	0.81 ± 0.04	0.79 ± 0.04	0.81 ± 0.04**
Total Body Fat (%BF)#	16.4 ± 5.0	16.6 ± 5.1	17.3 ± 5.7
Sum of 8 skinfolds (mm)	78.4 ± 32.6	80.1 ± 37.5	92.9 ± 43.5*, **
Ht-corrected sum of 8 skinfolds (mm)	77.8 ± 32.5	78.9 ± 36.5	87.3 ± 40.3
Corrected arm (cm)	25.6 ± 2.3	25.0 ± 2.2	28.2 ± 2.5*, **
Corrected calf (cm)	34.1 ± 2.2	33.9 ± 2.3	34.7 ± 2.3**
Somatotype	3.0-4.9-2.8	3.0-4.6-3.0	3.1-5.4-2.5

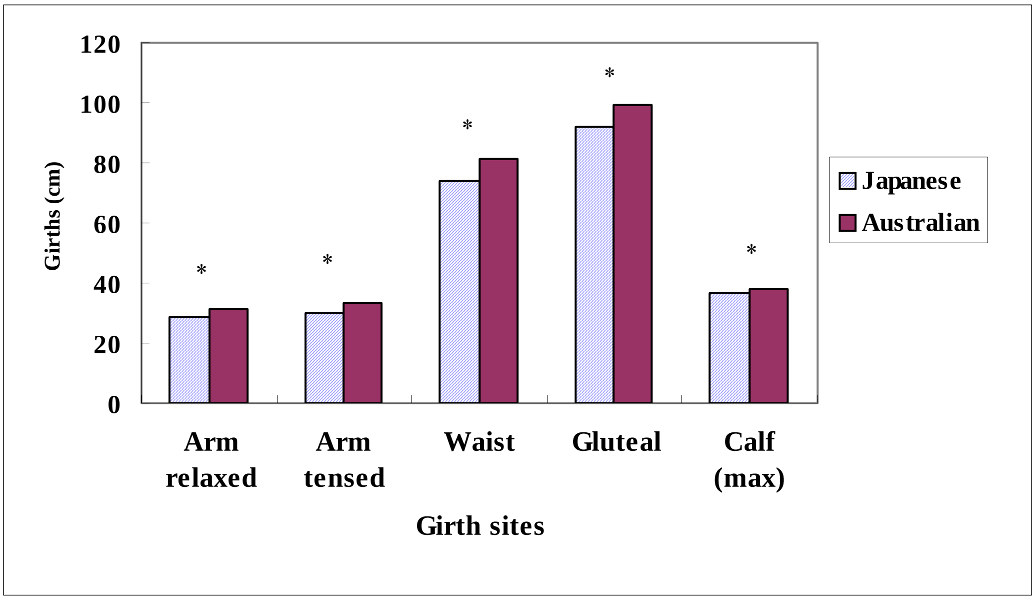
* Significant differences with Japanese living in Australia at the 0.05 level.
** Significant differences with Japanese living in Japan at the 0.05 level.
# %BF was calculated by a combination of Durnin and Womersley (1974) body density prediction equation and Siri (1961) %BF prediction equation.

Figure 4.1.3 Ethnic differences in subcutaneous fat distribution



* Significant ethnic difference at the 0.05 level.

Figure 4.1.4 Ethnic differences in measurements of girths

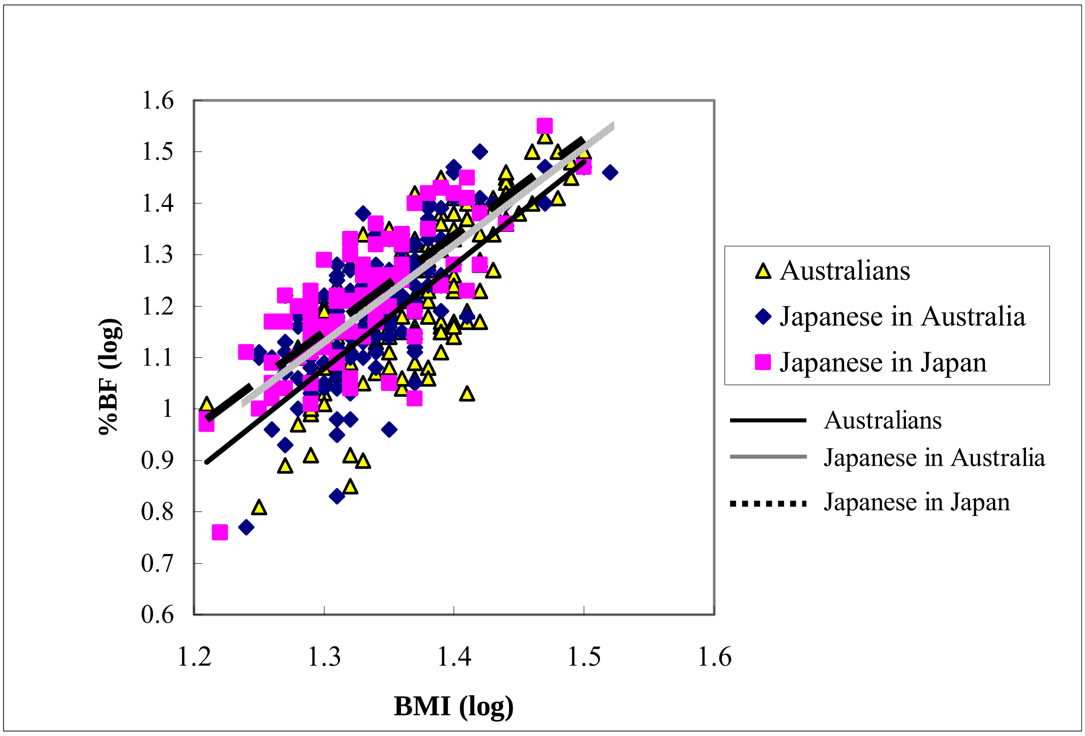


* Significant ethnic difference at the 0.05 level.

A stepwise multiple linear regression analysis was conducted to determine the BMI-%BF relationship. The BMI was used as an independent variable and %BF derived from anthropometry as the dependent variable. Figure 4.1.5 represents a scatter plot of BMI-%BF relationships for each group after log transformation. There were significant (*p*<0.05) ethnic differences in the BMI-%BF relationship between the Japanese groups and the Australians. No differences were found between the two

Japanese groups. The inclusion of age as a variable did not have a significant impact on the model and was therefore excluded from the final regression equation.

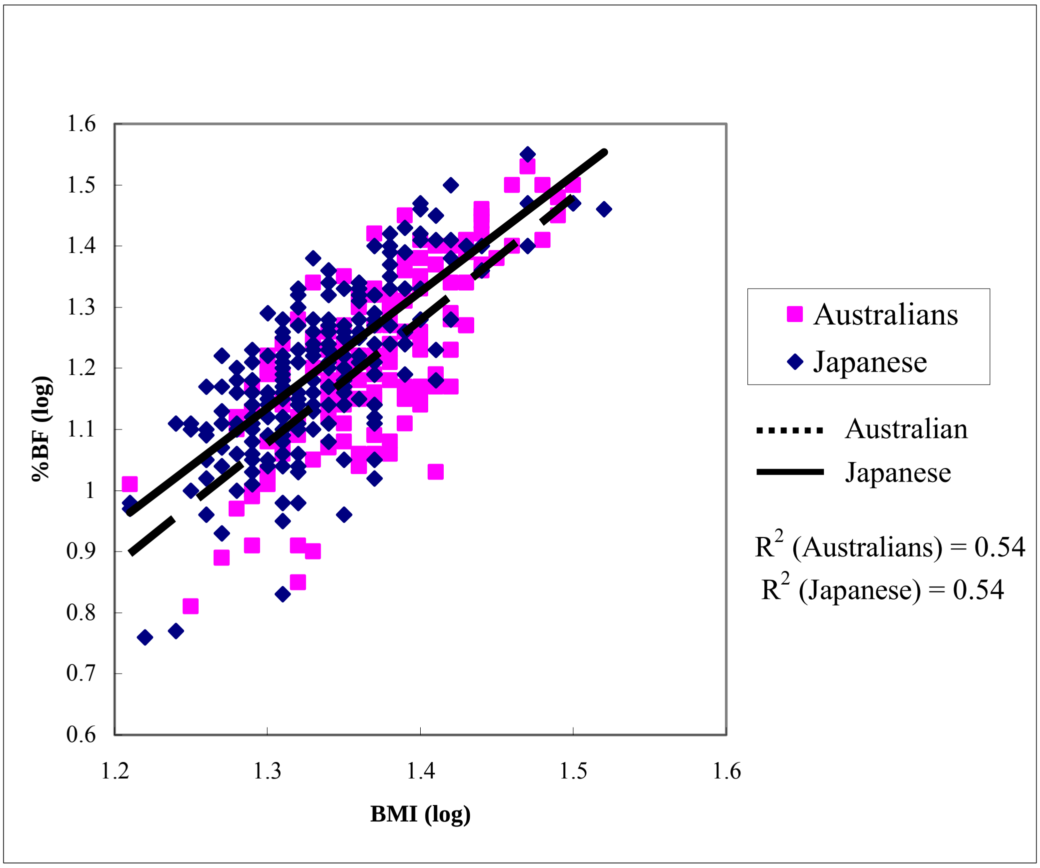
Figure 4.1.5 Differences in the BMI-%BF relationships between study groups[#]



[#] %BF was determined from anthropometry using a combination of Durnin and Womersley body density prediction equation (1974) and %BF prediction equation by Siri (1963).

As no significant differences were found between the JJ and JA groups, both groups were combined into one group (n = 233) and the ethnic difference in BMI-%BF relationship was then re-plotted as shown in Figure 4.1.6. These results show an ethnic difference in the relationship.

Figure 4.1.6 Ethnic differences in the BMI-%BF relationship between Japanese and Australian Caucasian males#



%BF from anthropometry was predicted using a combination of Durnin and Womersley body density prediction equation (1974) and %BF prediction equation by Siri (1963).

Table 4.1.6 represents "best fit" %BF prediction equations for Japanese and Australian males using the BMI. Using the prediction equation, %BF was estimated for the BMI values of 20, 25 and 30, which are classified as average, overweight and obese, respectively, by the WHO. At the BMI of 20, %BF values of Japanese and Australian males were 13.7 and 12.1. Similarly, at the BMI of 25, their %BF values were 20.9 and 18.8 respectively. The result suggests greater fat deposition by Japanese at any given BMI values than by Australian Caucasian males.

Table 4.1.6 Prediction equations for %BF using BMI as an independent variable

Groups	Equation	R^2	SEE
Japanese	Log %BF = -1.330 + 1.896(log BMI)	0.547	0.09
Australian	Log %BF = -1.522 + 2.001(log BMI)	0.544	0.10

To determine BMI values that reflect actual body composition, %BF values of Australian males at BMI values of 25 and 30 were entered into the prediction equation for Japanese males shown in Table 4.1.6 above (ie, Log %BF = -1.330 + 1.896(log BMI)). As shown in Table 4.1.7, the BMI of Japanese males whose %BF were equivalent to Australian Caucasian males, were 1.4 units (of BMI) below the WHO classification of "overweight" and "obese" respectively.

Table 4.1.7 Estimated BMI cut-off points for Japanese males with equivalent %BF with Australian-Caucasian males

BMI cut-off points (WHO Classification)	Japanese Log equation (Estimated – WHO value)
25 (Overweight)	**23.6 (-1.4)**
30 (Obese)	**28.6 (-1.4)**

4.1.4 Impact of inappropriate usage of the BMI classification to identify overweight and obesity

As shown above in Figure 4.1.6 and Table 4.1.7, Japanese males have a greater amount of %BF than Australian Caucasian males at any given BMI values and therefore their appropriate level of the BMI cut-off point may be 1.4 units lower than for Australian males. Functionally the %BF is more likely to have physiological importance than the BMI value that was calculated by stature and body mass alone. The application of BMI classifications that do not reflect body composition of the study group can cause a misclassification of individuals. In this section the impact of using inappropriate BMI classification to identify those who were overweight or obese is examined. The BMI classifications examined in the study were 1) the WHO classification using 25 as a cut-off point of overweight (WHO 1997a), and 2) the Asia-Pacific classification using 23 as a cut-off point of overweight (WHO/IASO/IOTF 2000).

Table 4.1.8 shows sensitivity and specificity of different BMI classifications for each study group. The cut-off point of 25 is the standard cut-off point for “Pre-obese” in the WHO classification. By comparison, the newly proposed Asia-Pacific classification used the BMI of 23 as a cut-off point of “Overweight (at risk)”. Application of the standard WHO classification to Japanese males identified only 33.3% of those who have %BF of above 20, whereas using the Asia-Pacific classification 64.7% of Japanese males with %BF above 20 were identified. By comparison, the application of the standard WHO classification to Australian Caucasian males enables the identification of 70% of those who have %BF of 20 and above and only increased to 90% by using the Asia-Pacific classification. Hence it can be assumed that the WHO standard classification is appropriate for Australian Caucasian males but not for Japanese males, if the sensitivity of the test is the major criteria.

Table 4.1.8 Difference in sensitivity and specificity of the WHO and Asia-Pacific BMI classifications

	%BF by anthropometry[#, ##]			
	Japanese (%)		Australian (%)	
BMI (Standard classification)	< 20	≥ 20	< 20	≥ 20
< 25	**97.8**	66.7	**87.4**	30.0
≥ 25	2.2	**33.3**	12.6	**70.0**
BMI (Asia-Pacific classification)	< 20	≥ 20	< 20	≥ 20
< 23	**86.8**	35.3	**60.2**	10.0
≥ 23	13.2	**64.7**	39.8	**90.0**

[#] According to previous recommendations (Nagamine 1972 and Wilmore, et al., 1986), %BF of 20 was used as a cut-off point of overweight.
[##] True positive and true negative values are printed in bold.

It has been suggested that the BMI value does not reflect the actual body composition of individuals hence misclassification can be expected. One of the issues raised in Japan is the presence of “masked obese” individuals (Kajioka et al. 1996a; Kajioka et al. 1996b; Suzuki & Matsuo 1996; Matsuura et al. 2001; Tobe et al. 2002), who appear thin but have an excessive amount of body fat. Several studies have suggested that this condition is a result of an attempt to lose body mass by dieting and without an adequate level of physical activity, which could lead to a loss of fat free mass (FFM), such as skeletal muscles (Suzuki & Matsuo 1996; Kajioka et al. 2002).

The results of this study suggest that the “masked obese” effect may simply reflect the higher level of %BF for a given level of BMI in Japanese subjects. Further studies are needed in Japan to see if this group still exists if a more appropriate BMI classification that reflects one’s body composition is used ie, the “masked obese” may simply be individuals who have been misclassified.

Table 4.1.9 shows differences in the proportion of individuals who were classified as “masked obese”, using an application of different BMI classifications. As shown in the table, a proportion of “masked obese” Japanese males using the standard WHO classification was almost twice as many (66%) of those classified by the Asia-Pacific classification (35%). In addition, the table also illustrates that there was no ethnic difference in those who were classified as “masked obese” (ie, 35% for Japanese, 30% for Australian males) when Asia-Pacific classification was used for Japanese and the standard WHO classification for Australian Caucasian males respectively, which are classifications that reflect body composition of each group.

Table 4.1.9 Ethnic differences in proportion of "masked obesity"[#] individuals using different BMI classifications

Classification	WHO standard		Asia-Pacific	
Ethnic group	**Japanese**	**Australian**	**Japanese**	**Australian**
Obese (persons)	51	40	51	40
Masked obese (persons)	34	12	18	4
Proportion of "Masked obese" within obese group (%)	66	30	35	10

[#] Masked obesity definition: A condition of excess total body fat deposition of individuals, whose body mass and the BMI are within the "average" or even "underweight" categories (Kajioka et al. 1996a).

4.1.5 Summary

In the body composition section of the results chapter the following findings have been reported:

1. Body density and percent body fat can be best predicted by a combination of the 'Durnin and Womersley (1974)' body density prediction equation and Siri's body fat prediction equation for both Japanese and Australian Caucasian males living in Australia.
2. While no difference in percent body fat (%BF) and height-corrected sum of skinfolds was found, Australian Caucasian males were taller, heavier, and had a greater BMI than Japanese males. Australian males also showed significantly greater trunk and lower body subcutaneous fat distribution than Japanese males.
3. Ethnic differences in the BMI-%BF relationship were found between the populations used in this study, confirming previously reported differences. Japanese males have greater total body fat (%BF) than Australian Caucasian males at any given BMI value. Japanese have the same proportion of %BF as their Australian counterparts at 1.4 units of BMI lower than the WHO classification of overweight and obesity.
4. To allow BMI to be used as an effective screening tool for obesity-related health problems, the use of a population-specific BMI classification that more accurately reflects their body composition is essential. The issue of "masked obesity" among the Japanese population has been discussed. However, the current study showed there were no ethnic differences in a presence of masked obese males when specific BMI classifications were used for each ethnic group.

Part II. Lifestyle

4.2.1 Introduction

It has been acknowledged that environmental variables, including physical activity and eating behaviour, are associated with body composition and body image formation (Paxton et al. 1991; Cattarin & Thompson 1994; O'Dea 1995; French et al. 1997). However, many cross-ethnic, cross-cultural body image studies did not obtain detailed information about lifestyle factors, such as nutrient intakes and attitudes toward eating. In this study, prior to making assessments of body image, information on a number of lifestyle variables of the study groups was obtained through questionnaires and dietary assessment. The lifestyle areas that were assessed included 1) living conditions, 2) eating habits, 3) physical activity, and 4) nutrient intakes. Because no major significant differences were found between the baseline assessment and follow-up assessments, results from the baseline assessment are reported in this chapter. The follow-up results are attached as Appendix Eight. The methodology chapter of the thesis has details on questionnaires and nutrient intake analysis.

4.2.2 Ethnic and cultural differences in the lifestyle of Japanese and Australian Caucasian males living in Perth, Western Australia and Japanese males living in Himeji, Japan

I. Demographic

Table 4.2.1 shows demographic information, including marital and occupational status, language spoken at home and other living conditions, of the study groups.
While there was no difference in their marriage status, occupational status differed significantly between the groups ($p<0.05$). However, the difference between the reported occupations of the JA and JJ may not be a real difference. This was due to the number of JA subjects who reported their occupations as "Working holiday" visa-holders. This is a class of visa for young people that allow them to attend educational institutions but they are also able to work for a longer period than those

who have a student visa. The majority of the JA subjects were recruited at educational institutions.

The reported sleeping patterns differed between the Australian and Japanese groups, with 18% of Japanese males living in Japan sleeping less than five hours each day. At the opposite end of the spectrum, 4.4% and 4.2% of Japanese and Australian males living in Australia slept more than 10 hours a night respectively. 50% of JA and 48.6% of AA reported that they shared their accommodation with others, while 46.4% of JJ responded that they lived alone. More than 70% of the JA subjects used English as their main language at home at the time of the assessment.

Table 4.2.1 Demographic characteristics of the study groups

Question	Responses	JA (n=68) (%)	JJ (n=84) (%)	AA (n=72) (%)
Marital status	Married	5.9	1.2	5.6
	Never married	94.1	98.8	94.4
Occupation [A, B, C]	Student	76.5	100.0	65.3
	Worker	1.5	0.0	25.0
	Working holiday	20.6	0.0	0.0
	Other	1.5	0.0	9.7
Place of birth [A, B]	Japan	100.0	100.0	0.0
	Australia/New Zealand	0.0	0.0	86.1
	Other countries	0.0	0.0	13.9
Language spoken at home [A, B, C]	Japanese	25.0	100.0	98.6
	English	52.9	0.0	0.0
	Both	22.1	0.0	0.0
	Other language	0.0	0.0	1.4
Person (s) living with [B, C]	Alone	2.9	46.4	6.9
	Family/host family	47.1	51.2	44.4
	Spouse/Share mate	50.0	2.4	48.6
Hours of sleep [B, C]	5 hours or less	2.9	17.9	0.0
	6-7 hours	55.9	70.2	51.4
	8-9 hours	36.8	11.9	44.5
	10 hours or more	4.4	0.0	4.2

[A] = Significantly different between JA and AA at the 0.05 level
[B] = Significantly different between JJ and AA at the 0.05 level.
[C] = Significantly different between JA and JJ at the 0.05 level.

II. Eating habits

The eating habits of the study groups were documented using a self-administered questionnaire that contains questions from the Japanese National Nutrition Survey (JNNS) and the Hawaii' Cancer Research Survey. Table 4.2.2 reports usual eating practices obtained from the questionnaire. No significant differences in eating practices were observed between the Japanese groups living in Japan and Australia. Australian Caucasian males reported greater ($p<0.05$) awareness of the content of the food that they consumed. In addition, more than 20% of them reported consuming a specific diet, such as low meat diet, a high fish diet, or trying to consume a large amount of fruit and vegetables. In comparison with Japanese groups, a larger proportion of the Australians regularly consumed three meals a day.

Table 4.2.2 Responses on eating habits among study groups

Questions	Response	JA (n=68) (%)	JJ (n=84) (%)	AA (n=72) (%)
Eat three meals a day [B]	Yes	67.6	65.5	80.6
	No	32.4	34.5	19.4
Frequency of missing breakfast	Eat everyday	61.8	57.1	77.8
	Miss 2-3 days/week	10.3	14.3	8.3
	Miss 4-5 days/week	7.4	8.3	4.2
	Do not eat almost always	20.6	20.2	9.7
Aware of content of food [A, B]	Yes	36.8	38.1	76.4
	No	63.2	61.9	23.6
Type of diet [A, B]	No specific diet	94.1	97.6	73.6
	Vegetarian	1.5	1.2	1.4
	Weight reduction	0.0	0.0	4.2
	Fat modified	2.9	0.0	2.8
	Other	1.5	1.2	18.1

[A] = Significantly different between JA and AA at the 0.05 level.
[B] = Significantly different between JJ and AA at the 0.05 level.
[C] = Significantly different between JA and JJ at the 0.05 level.

III. Physical activity

The frequency and intensity of physical activity were also assessed (Table 4.2.3). Significant differences in hours involved in strenuous (eg, jogging and tennis) and moderate (eg, housework, gardening, and golf) levels of exercise were found between the Australian and Japanese males (p<0.05). In comparison to Japanese groups (27.9% JA and 14.3% JJ respectively), a smaller proportion (1.4%) of the Australian males responded that they were never involved in vigorous physical activity.

Table 4.2.3 Differences in physical activity levels between the study groups

Questions	Response	JA (n=68) (%)	JJ (n=84) (%)	AA (n=72) (%)
Hours involved in strenuous exercise (per week) [A, B]	None	33.8	25.0	6.9
	0.5-3 hours	41.2	47.6	48.6
	4-10 hours	22.1	19.0	34.7
	11-30 hours	1.5	8.3	8.3
	31 hours or more	1.5	0.0	1.4
Hours involved in vigorous exercise (per week) [A]	None	50.0	36.9	20.8
	0.5-3 hours	36.8	42.9	48.6
	4-10 hours	8.8	16.7	26.4
	11-30 hours	4.4	3.6	4.2
	31 hours or more	0.0	0.0	0.0
Hours involved in moderate exercise (per week) [A, B]	None	36.8	25.0	2.8
	0.5-3 hours	33.8	38.1	55.6
	4-10 hours	20.6	29.8	33.3
	11-30 hours	2.9	6.0	8.3
	31 hours or more	5.9	1.2	0.0
Frequency of vigorous exercise (per week) [A, B]	Never	27.9	14.3	1.4
	1-3 times	41.2	61.9	51.4
	4-6 times	20.6	15.5	36.1
	7 or more times	10.3	8.3	11.1

[A] = Significantly different between JA and AA at the 0.05 level.
[B] = Significantly different between JJ and AA at the 0.05 level.
[C] = Significantly different between JA and JJ at the 0.05 level.

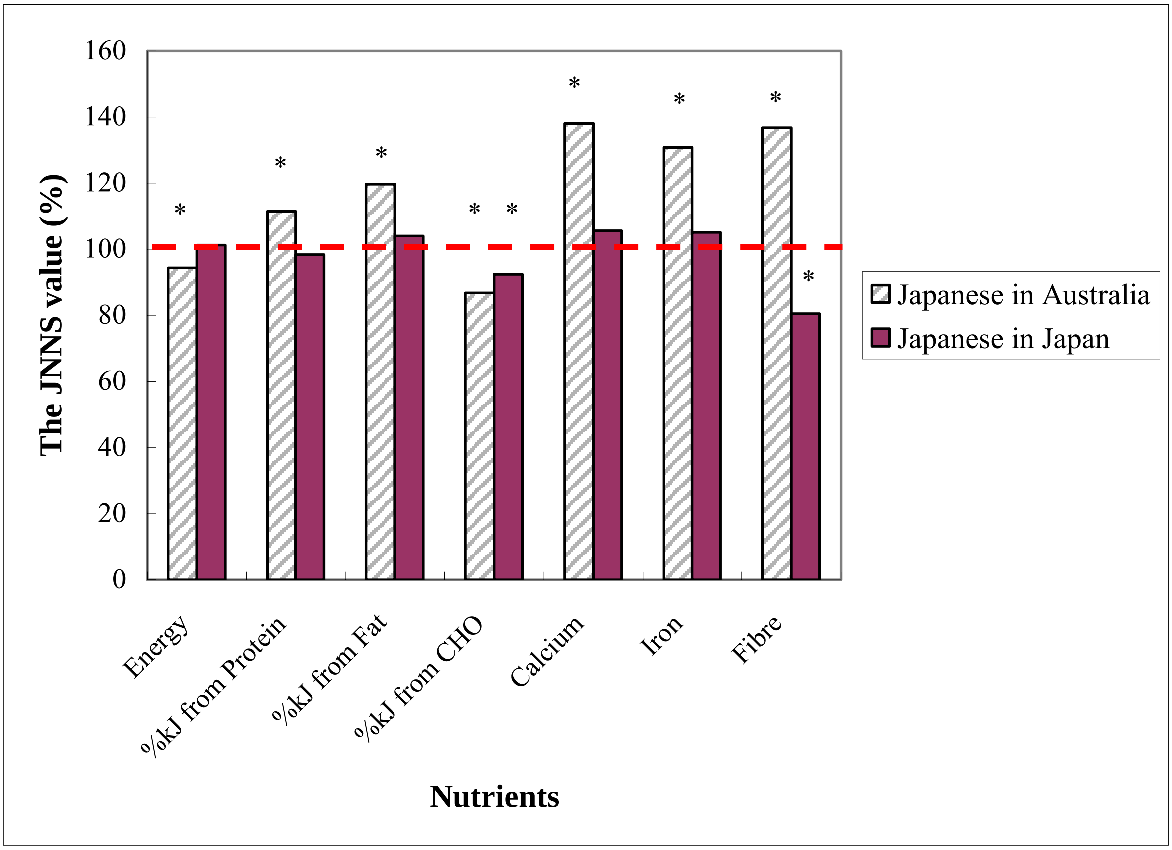
In addition to the abovementioned variables, Japanese subjects were asked to complete the SL-ASIA questionnaire to assess the level of Westernised values held by the study group. Using the results obtained from 68 JA and 86 JJ subjects, difference in their Westernised attitude was assessed. In comparison to JJ group, JA showed a lower score (JJ: 32.6 ± 2.7; JA: 27.8 ± 3.1, $p<0.05$), which indicates a greater Westernised attitude possessed by the JA group. The results from SL-ASIA questionnaire did not show strong correlations with other lifestyle variables.

4.2.3 Ethnic and cultural differences in nutrient intakes: Comparison between Japanese and Australian Caucasian males living in Australia and Japanese males living in Japan

Diet is one of the variables that can be affected by place of residence. In comparison with Japanese living in Japan, it is possible that nutrient intakes of Japanese living in Western countries may change to a more Westernised pattern. There are several studies that have examined the nutrient intakes of Japanese living overseas (Kim et al. 1993; Kudo, Falciglia & Couch 2000; Freire et al. 2003). However, many of the reported studies are on older females or people of Japanese ancestry (eg, Japanese-Americans in Hawaii or Japanese-Brazilians), whose food selection and nutrient intakes are more likely to be influenced by foreign cultures, because of the period of time they have been away from Japan. In comparison with females, there is a lack of reported information on nutrient intakes of young Japanese males who are living overseas. There are no reported studies that have examined differences in nutrient intakes of Japanese males living overseas with those living in Japan.

The nutrient intakes were first compared with the equivalent results from the National Nutrition Survey conducted in both Japan (KEJK 2003) and Australia (McLennan & Podger 1998) to assess differences with reported values (Figure 4.2.1 and 4.2.2). Apart from the energy contribution from carbohydrate and dietary fibre, data obtained from the JJ was comparable to the same age group data of the Japanese National Nutrition Survey (JNNS). The intakes of major nutrients by the JJ group were similar to the equivalent age group in the JNNS, suggesting that the JJ sample was representative of the average Japanese for this age group. In comparison to JJ, nutrient intakes of JA significantly differed from the JNNS result. While they consumed significantly ($p<0.05$) lower total energy and energy contribution from carbohydrate, they had a significantly greater energy contribution from protein and fat, as well as higher calcium, iron and dietary fibre intakes ($p<0.05$).

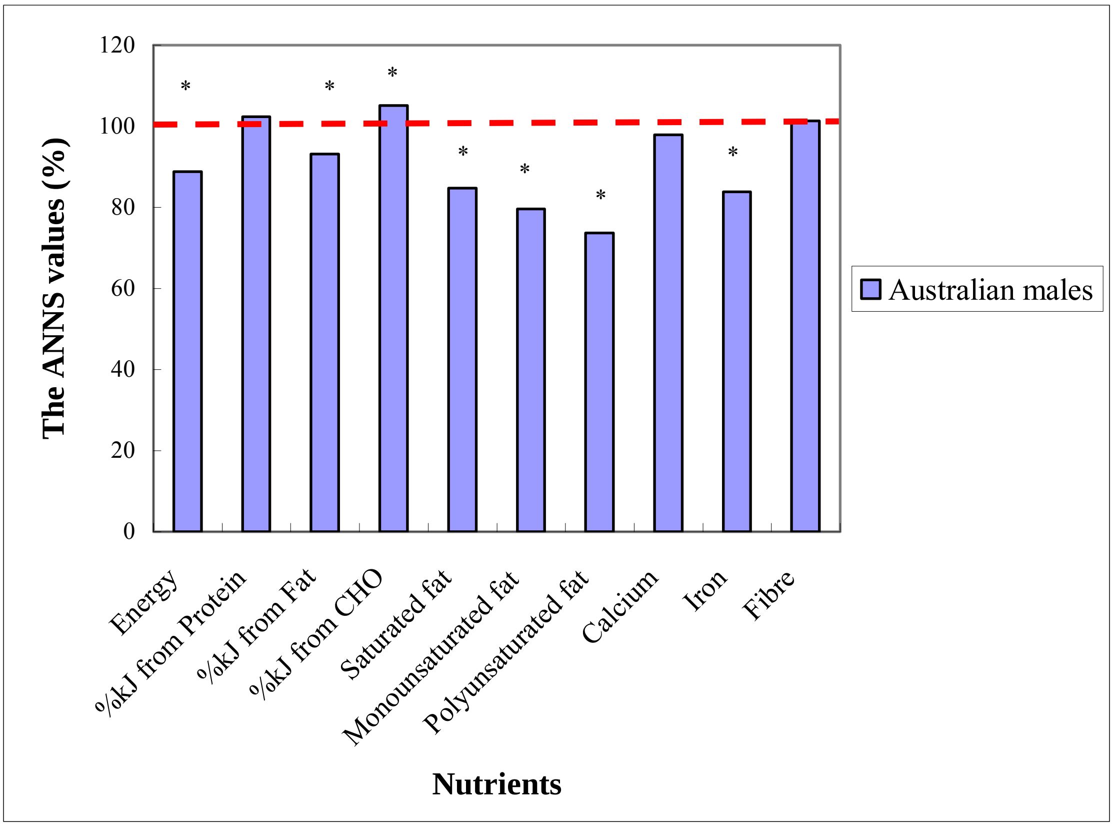
Figure 4.2.1 Nutrient intakes of Japanese groups compared with the Japanese National Nutrition Survey[#, ##]



* Significantly different from the JNNS value at the 0.05 level.
[#] Adopted and modified from the 2001 results of the Japanese National Nutrition Survey (KEJK 2003), males aged 20-29 years old. Energy value originally in kcal was converted by multiplying 4.184kJ.
[##] Red line represents the mean JNNS value of males aged 20-29 years old.

Australian males also showed similar values to the nutrient intakes of the equivalent age group in the Australian National Nutrition Survey (ANNS). There were no significant differences in energy contribution from protein and intakes of calcium and dietary fibre. However, the total energy consumption and the energy contribution from fat of Australian Caucasian males and their intakes of iron, saturated-, mono- and polyunsaturated fat were significantly lower than the values reported in the ANNS. In addition, their energy contribution from carbohydrate was significantly higher than the ANNS value.

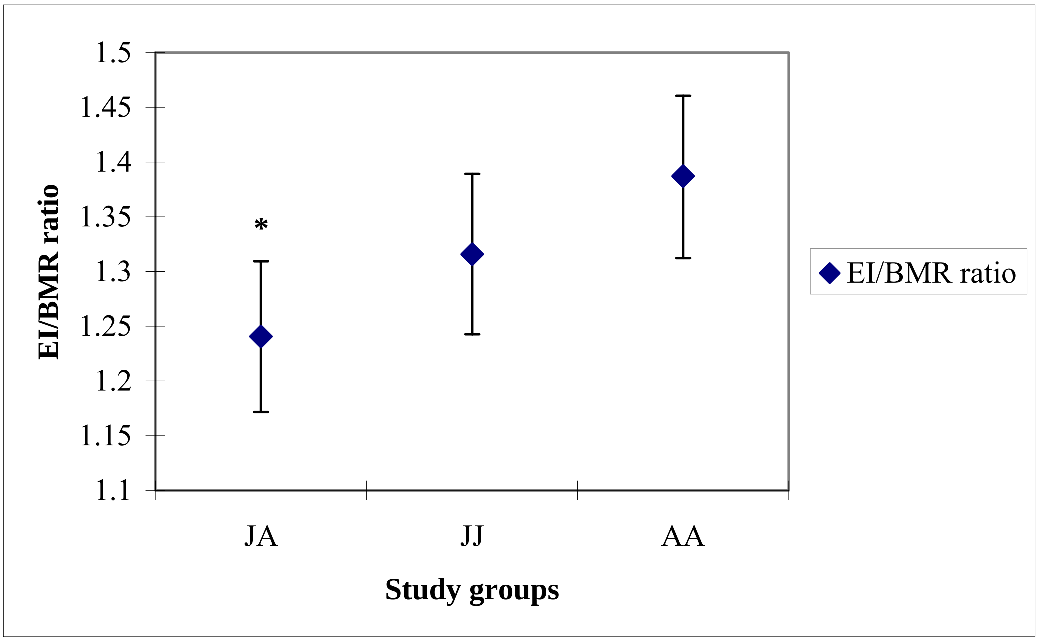
Figure 4.2.2 Nutrient intakes of Australian Caucasian males compared with the Australian National Nutrition Survey#, ##



* Significantly different from the ANNS value at the 0.05 level.
[#] Adopted and modified from the Australia National Nutrition Survey (1995)(McLennan & Podger 1998), males aged between 19 and 44 years old.
[##] Red line represents the mean ANNS value of males aged between 19 and 44 years old.

The energy intake to the basal metabolic rate ratio (EI/BMR ratio) (Barbara, Livingstone & Black 2003) was calculated for each individual in each of the study groups (Figure 4.2.3). The average EI/BMR ratio of JA, JJ, and AA were 1.24, 1.32, and 1.39 respectively. The values were significantly different between the JA and AA groups but the JJ group did not show significant differences with either JA or AA groups. The results may indicate that Japanese males living in Australia have low energy intakes in relation to their energy requirement compared with Australian Caucasian males.

Figure 4.2.3 Differences in the EI/BMR ratio between the study groups



* = Significantly different from the AA value at the 0.05 level.

Table 4.2.4 shows differences in nutrient intakes between the study groups. There were significant ethnic differences in total energy, protein, total fat, zinc, vitamin A equivalent, thiamin, riboflavin, and vitamin C (p<0.05). Among these nutrients, intakes of calcium, iron, dietary fibre, and niacin equivalent by the JA group were in between the results obtained from JJ and AA groups. Energy contributions from major nutrients (ie, protein, carbohydrate and fat) as well as from different fat types were also different between Japanese living in Japan and those living in Australia (p<0.05). Japanese living in Japan consumed more energy from carbohydrate and polyunsaturated fat than those living in Australia. Apart from monounsaturated fat, JA and AA did not show any differences in their energy contributions from major nutrients and fat types.

Table 4.2.4 Nutrient intakes of study groups

Nutrients	JA (n =65) ± SD	JJ (n =81) ± SD	AA (n =70) ± SD
Total energy (kJ) [A, B, C]	8533.5 ± 1868.0	9171.3 ± 2190.2	11096.2 ± 2436.8
Protein (g) [A, B]	82.3 ± 25.7	77.9 ± 21.4	111.1 ± 27.9
Total fat (g) [A, B]	75.0 ± 22.3	70.3 ± 23.1	91.4 ± 25.7
Carbohydrate (g) [A, B, C]	237.2 ± 57.3	286.4 ± 69.2	318.2 ± 84.7
Cholesterol (mg) [A, C]	317.7 ± 139.8	410.7 ± 169.7	344.9 ± 148.1
Calcium (g) [A, B, C]	648.9 ± 267.6	496.3 ± 218.6	1022.8 ± 384.1
Iron (g) [A, B, C]	10.2 ± 3.2	8.2 ± 2.2	14.5 ± 4.5
Zinc (g) [A, B]	10.3 ± 3.8	9.7 ± 2.8	13.7 ± 3.7
Dietary fibre (g) [A, B, C]	17.5 ± 5.2	10.3 ± 3.5	26.5 ± 9.7
Vitamin A equivalent (µg) [A, B]	707.9 ± 347.9	775.7 ± 810.5	1125.6 ± 1162.2
Thiamin (mg) [A, B]	1.19 ± 0.39	1.05 ± 0.32	2.09 ± 0.94
Riboflavin (mg) [A, B]	1.37 ± 0.90	1.41 ± 0.53	2.51 ± 1.15
Niacin equivalent (mg) [A, B, C]	35.1 ± 11.7	17.7 ± 5.4	50.8 ± 13.5
Vitamin C (mg) [A, B]	94.6 ± 62.9	79.9 ± 39.8	156.8 ± 98.3
Total folate (µg) [A, C]	204.7 ± 63.3	297.3 ± 153.1	329.2 ± 123.1
Energy contribution from			
Protein (%) [B, C]	16.3 ± 3.1	14.4 ± 2.0	17.1 ± 3.7
Carbohydrate (%) [B, C]	47.3 ± 6.7	50.4 ± 6.1	47.9 ± 6.0
Fat (%) [B, C]	32.3 ± 5.7	28.1 ± 5.0	30.6 ± 5.7
Energy contribution from			
Monounsaturated fat (%) [A, B, C]	12.3 ± 2.6	9.7 ± 2.2	11.0 ± 2.3
Polyunsaturated fat (%) [B, C]	4.5 ± 1.2	5.6 ± 1.5	4.0 ± 1.1
Saturated fat (%) [B, C]	12.5 ± 2.7	7.9 ± 2.0	12.8 ± 3.3

[A] = Significant difference between AA and JA at the 0.05 level.
[B] = Significant difference between AA and JJ at the 0.05 level.
[C] = Significant difference between JA and JJ at the 0.05 level.

4.2.4 Summary

In this section differences were examined in lifestyle variables between the study groups. Findings include:

1. Japanese males recruited in Australia had similar living conditions to the sample of Australian Caucasian males. Approximately half of the JJ group reported that they lived alone, whereas groups living in Australia split into two; those living with family or host families and those living with share mates. Both groups in Australia also slept longer than the JJ group.
2. Australian males showed more awareness about the nutrient content of the food they consume when compared to the responses of both Japanese male groups. Australian males were also more active in participating in strenuous and moderate physical activities than their Japanese counterparts.
3. Australian males were also more active in participating in strenuous and moderate physical activities than their Japanese counterparts.
4. The eating habits and physical activity level of Japanese males living in Australia did not differ significantly from those living in Japan.
5. Ethnic and environmental differences in nutrient intakes were found between the groups in the study. The AA group showed greater nutrient intakes than Japanese group living in Australia. The environmental influences were shown by the differences between the JA and the JJ groups. The Japanese living in Australia had patterns of energy contributions from the macronutrients similar to the Australians.

Part III. Body image

4.3.1 Introduction

The number of reported body image studies on males is limited compared to the number of studies using females. Male subjects have rarely been used in the study of ethnic differences in body image; most reported studies have used female subjects. Most reported studies have shown a link between distorted body image and abnormal eating behaviours, such as disordered and eating disorders (Cattarin & Thompson 1994; French et al. 1997). Also there have been a few studies reported that have directly related body image to a person's actual body composition. This section focuses on assessments of various aspects of body image (ie, body acceptability, body satisfaction, and body perception) in relation to ethnicity and anthropometrical variables using three groups (ie, JA, JJ, and AA).

Prior to the assessment, the validity of three instruments was examined. They were; 1) the Somatomorphic Matrix computer program (SM), 2) the Ben-Tovim Body Attitudes Questionnaire (BAQ), and 3) the Attention to the Body Shape Scale (ABS). The SM computer program is one of a limited numbers of instruments that may be used to assess body image in relation to body composition variables. However, it has not been validated against body composition results obtained using advanced methods. Also the validity of the SM program has not been assessed in cross-ethnic studies with Asian subjects. In this section, the body image profiles obtained from the SM program were compared with data on body composition using the DXA. For this validation study the sample of 45 Japanese and 42 Australian Caucasian males living in Australia were used.

The reliabilities and validities of the Ben-Tovim Walker Body Attitudes Questionnaire (BAQ) have been confirmed in other studies using female subjects but not males (Ben-Tovim & Walker 1991). Similarly, the Attention to the Body Shape Scale questionnaire (ABS) used small number of males and its applicability was assessed mainly using females (Beebe 1995). Hence the current study examined their validity and reliability using three study groups. As there is no previous report on males, the observed results from these questionnaires were compared with the previously reported results, which were mainly obtained from females (Ben-Tovim & Walker 1991; Beebe 1995) The Eating Attitudes Test (EAT) has frequently been used world wide and is accepted as a screening tool for disordered eating (see section 3.3.4 in the Methodology Chapter). In order to determine the validity of the BAQ and the ABS questionnaires to detect disordered eating in male groups used in this study, the EAT was used as the criterion. Details of instruments and methods used in studies in this section were explained in Chapter Three of this thesis.

4.3.2 Validation of the Somatomorphic Matrix program

The Somatomorphic Matrix program (SM) (Gruber, Pope Jr. & Borowiecki III 1998) used percent body fat (%BF) as an indicator for fatness. To measure muscularity, the programmer used fat free mass index (FFMI), which was proposed by Kouri, et al. (1995). The FFMI however, has not been used in past reported body composition studies using Japanese subjects. Hence, before assessing the validity of the SM program itself, in this study the applicability of the FFMI values to both Japanese and Australian Caucasian males was first assessed.

The fat free mass index was calculated using %BF values obtained from the whole-body DXA scan. The obtained FFMI result was significantly different between JA and AA groups ($p<0.05$) (Table 4.3.1). Correlations between FFMI and body composition variables obtained from DXA scan showed moderate associations with body mass, lean body mass obtained from the DXA scan, and FFM calculated using %BF from the DXA scan (Table 4.3.1). However, no significant correlations were obtained for %BF and FM results regardless of ethnicity.

Table 4.3.1 Mean FFMI and its correlation with measured anthropometry variables obtained from DXA scan

	Japanese (n = 45) **Mean ± SD**	**Australian (n = 42)** **Mean ± SD**
FFMI from DXA†	18.03 ± 1.37	19.22 ± 1.66
Correlation between FFMI	**R (R^2, SEE)**	**R (R^2, SEE)**
Body mass	0.594** (0.352, 1.12)	0.310* (0.096, 1.59)
%BF by DXA	0.055 (0.003, 1.39)	-0.083 (0.007, 1.67)
FM from DXA#	0.196 (0.038, 1.36)	0.016 (0.000, 1.68)
Lean body mass from DXA#	0.630** (0.397, 1.08)	0.455** (0.207, 1.49)
FM calculated from %BF##	0.215 (0.046, 1.36)	-0.009 (0.000, 1.68)
FFM calculated from %BF##	0.640** (0.409, 1.08)	0.488** (0.239, 1.46)
Corrected arm girth	0.645** (0.416, 1.06)	0.744** (0.553, 1.12)
Corrected calf girth	0.697** (0.486, 1.00)	0.566** (0.320, 1.38)

† Significantly different between Japanese and Australian Caucasian males at the 0.05 level.
* Significant at the 0.05 level.
** Significant at the 0.01 level.
# Fat and lean body mass obtained from the whole-body DXA scan (ie, sum of head, trunk, arms and leg results).
FM calculated from the equation FM = %BF*body mass, using %BF obtained from DXA scan. Similarly, FFM was calculated using the equation FFM = body mass – FM.

The FFMI was also correlated with corrected girths measurements for both study groups. To determine differences between FFMI and corrected girths (ie, arm and calf) in relation to the measured fat and lean mass obtained from DXA scanning, for following groups of correlations were calculated:

1) FFMI and fat mass of right arm and right leg obtained from DXA,
2) FFMI and lean mass of right arm and right leg obtained from DXA,
3) Corrected girths (ie, arm and calf) and fat mass of right arm and right leg obtained from DXA, and
4) Corrected girths (ie, arm and calf) and lean mass of right arm and right leg obtained from DXA

The results are shown in Table 4.3.2. The FFMI showed moderate correlations with lean body mass of the regions (JA: r = 0.757 for right arm, r = 610 for right leg; AA: r = 0.731 for right arm, r = 0.447 for right leg), that were comparable to the results obtained from the corrected girths (JA: r = 0.789 for arm, r = 0.694 for leg; AA: r = 0.896 for arm, r = 0.658 for leg). In addition, while both corrected calf girth and

FFMI did not correlate with fat mass of the regions, corrected arm girth correlated moderately with fat mass of Japanese males (0.565 for right arm and 0.437 for right leg). The results suggest that while a corrected arm girth may not differentiate lean and fat mass of the body region precisely in Japanese males, both corrected girths and FFMI can be used as an indicator of muscularity.

Table 4.3.2 Correlations between corrected girths and FFMI with lean and fat mass of right limbs obtained from DXA scan

	Japanese (n = 45) (r)			**Australian Caucasians (n = 42) (r)**		
	Corrected arm	Corrected calf	FFMI	Corrected arm	Corrected calf	FFMI
Lean mass						
Right arm	0.789**	0.634**	0.757**	0.896**	0.505**	0.731**
Right leg	0.463**	0.696**	0.610**	0.556**	0.658**	0.447**
Fat mass						
Right arm	0.565**	0.248	0.205	-0.047	0.217	-0.080
Right leg	0.437**	0.218	0.135	-0.031	-0.095	-0.082

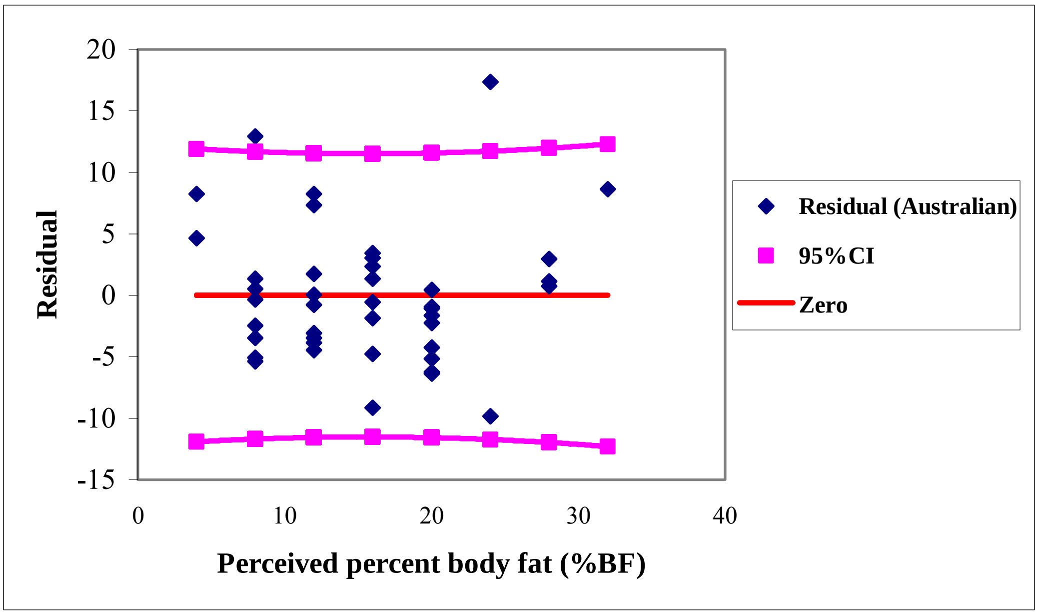
** Correlation is significant at the 0.01 level.

The Somatomorphic Matrix (SM) computer program provides a range of illustrations of different physiques to subjects and asked subjects to select one illustration according to the question given. Figure 4.3.1 and 4.3.2 represent difference in %BF and FFMI values between the illustration selected by each subject according to their perception of their "current physique" and their measured body composition by DXA. For both Japanese and Australian groups there was a wide range in the %BF values obtained from the SM program compared to their measured %BF as measured by DXA. For example in Figure 4.3.1, the variation as high as 10 percentage points greater or lesser than the criterion values (mean $\%BF_{(DXA\text{-}SM)}$ for JA = -1.99, SD = 7.23; mean $\%BF_{(DXA\text{-}SM)}$ for AA = 0.35, SD = 6.90).

For FFMI, approximately ±3kg/m^2 difference between the value of the selected illustration and the measured value of the subjects was observed (Figure 4.3.2). No significant ethnic differences were observed in differences between body composition values from their selected "current physique" illustration and the measured body composition values of the subjects.

Figure 4.3.1 Discrepancies between %BF obtained from the SM program and DXA results for a) Australian Caucasian and b) Japanese males living in Australia

a) Australian Caucasian males



b) Japanese males living in Australia

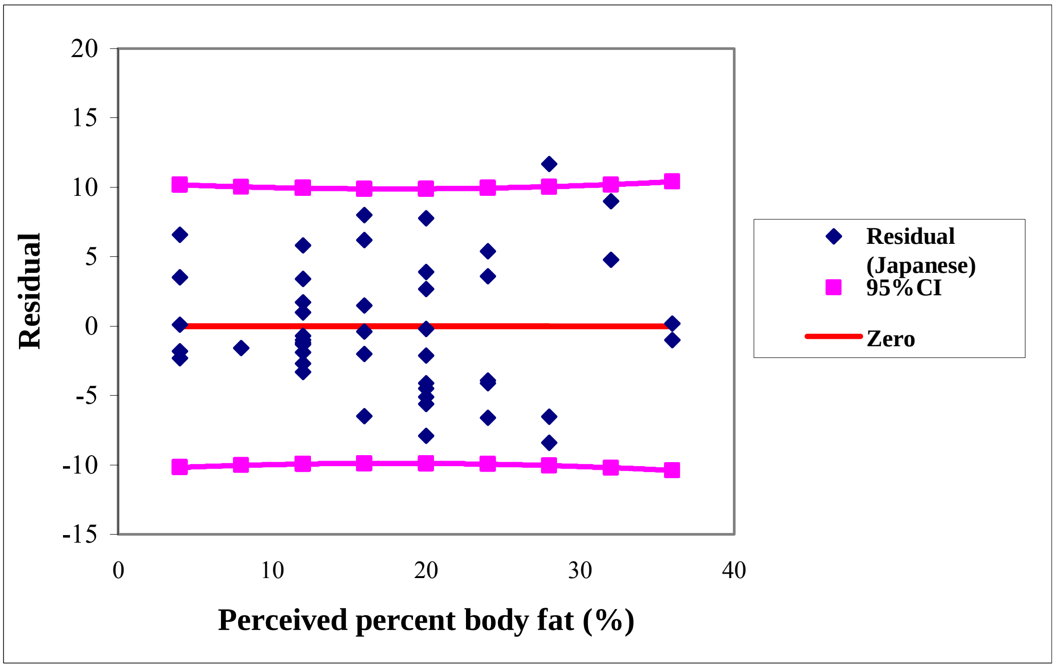
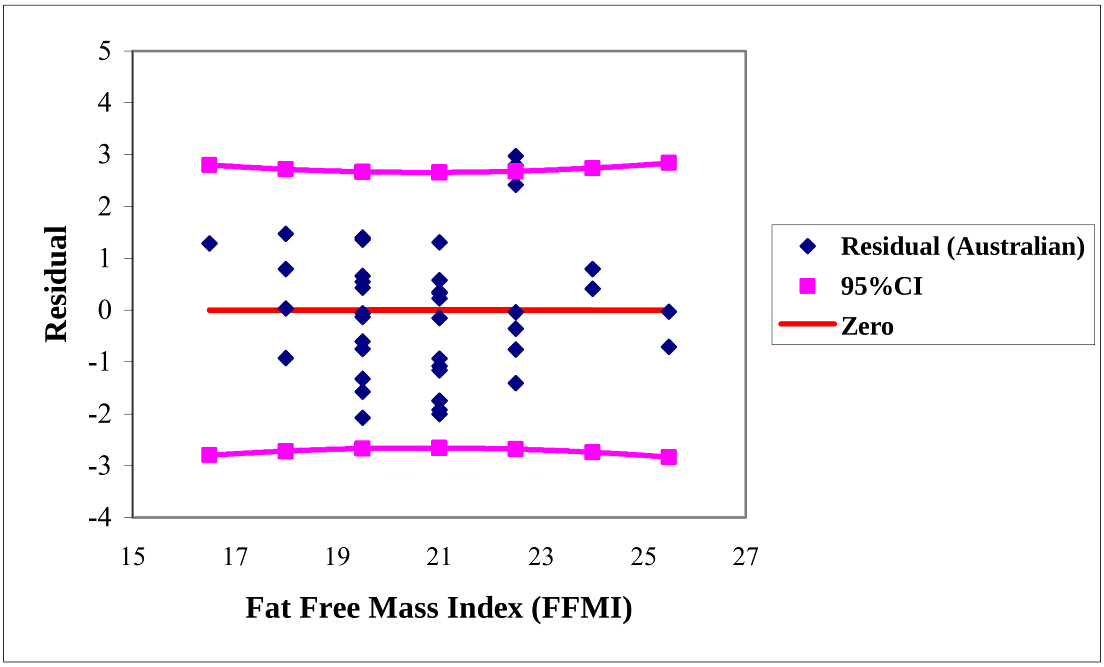
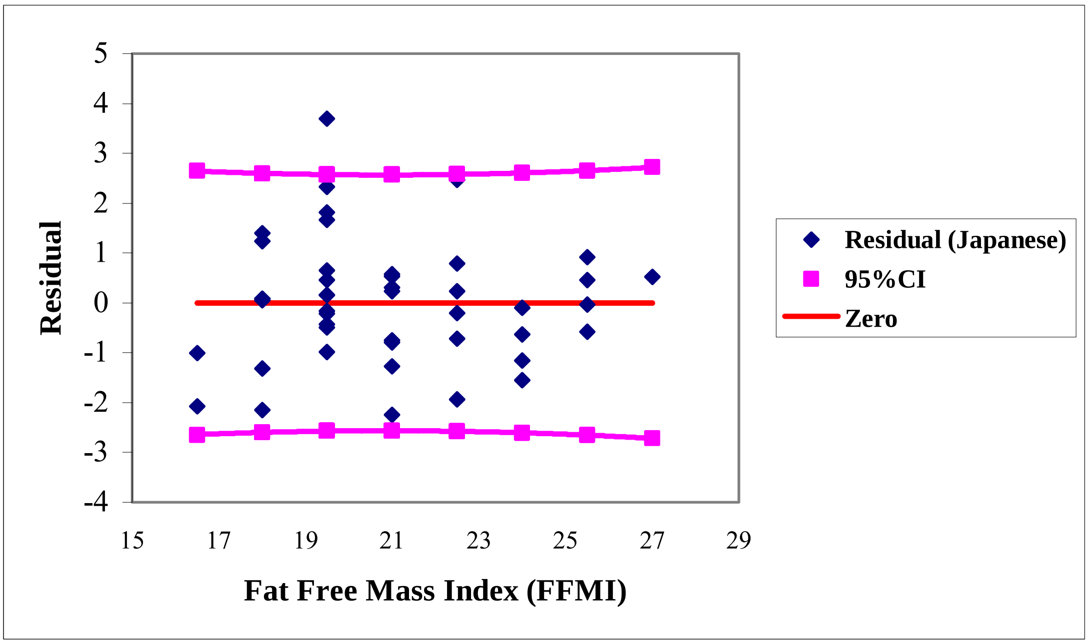


Figure 4.3.2 Discrepancies between FFMI obtained from the SM program and DXA results for a) Australian Caucasian and b) Japanese males living in Australia

a) Australian Caucasian males



b) Japanese males living in Australia



4.3.3 Validation of BAQ and ABS: Applicability to Japanese and Australian males

There are a number of questionnaires that have been used to assess attitudes towards body appearance and eating behaviours. The Ben-Tovim Walker Body Attitudes Questionnaire (BAQ) is used to assess the body attitude of subjects from multiple aspects. By contrast, the Attention to Body shape Scale (ABS) is used to assess a level of concern towards one's body appearance. As it is important to identify variables that may cause the group to be more at risk of developing body image-related health problems, administration of these questionnaires may help identify these factors. However, these questionnaires have been used more frequently on females and consequently the validity of these questionnaires when administered to males, especially Japanese males, has never been reported in detail. In this section, the validities of the BAQ and ABS for both Australian Caucasian males and Japanese males were assessed. There have been no previous studies reporting the validity of the BAQ with males. Hence the results obtained from Australian Caucasian males were first compared with the results previously reported using Australian females to determine gender differences in the results (Ben-Tovim & Walker 1991). The results obtained from Japanese males were then compared with Australian males to determine ethnic differences. Similarly, consistency and repeatability of the ABS results obtained from Japanese and Australian males were compared with the results originally reported using females and a small number of males (Beebe 1995).

Table 4.3.3 shows BAQ and ABS total scores and Cronbach's alpha obtained from each study group. Cronbach's alpha was used to examine the level of internal consistency of the questionnaires. The value for the BAQ ranged from 0.86 to 0.87 at the baseline and similarly, the value for the ABS ranged from 0.78 to 0.80. At 12 months follow-up, the JJ group showed Cronbach's alpha of 0.85 for the BAQ and 0.75 for the ABS and the AA group showed 0.86 for BAQ and 0.82 for ABS. This indicates that both the BAQ and ABS have high internal consistencies when administered to Japanese and Australian Caucasian males.

Table 4.3.3 BAQ and ABS scores and alpha values at the baseline and follow-up assessments

		Body Attitude Questionnaire (BAQ)		Attention to Body Shape Scale (ABS)	
		Mean ± SD	**Alpha**	**Mean ± SD**	**Alpha**
Baseline	**JA (68)**	110.8 ± 17.0	0.8721	21.5 ± 4.1	0.7788
	JJ (84)	109.5 ± 16.7	0.8683	20.9 ± 4.4	0.7943
	AA (72)	107.0 ± 14.8	0.8562	21.2 ± 4.8	0.7965
12 months follow-up	**JJ (60)**	111.3 ± 15.0	0.8528	21.6 ± 4.0	0.7501
	AA (47)	110.0 ± 16.1	0.8635	21.0 ± 4.9	0.8200

Using the baseline results, inter-correlations of BAQ subscales were shown in Table 4.3.4 below. The Japanese counterparts showed similar levels of inter-correlations between the BAQ subscales to Australian males. However, Japanese groups showed significant positive correlations between lower body fat subscale and strength subscale (JA: $r = 0.314$, JJ: $r = 0.406$) whereas there was no significant correlation found for Australian males (AA: $r = -0.177$). Also, unlike the JJ group, both JA and A groups showed similar correlations between feeling fat subscale and attractiveness subscale (JA: $r = -0.310$, AA: $r = -0.247$).

Table 4.3.4 Inter-correlations between BAQ subscales

		(I)	(II)	(III)	(IV)	(V)
Feeling fat (I)	**JA**					
	JJ					
	AA					
Disparagement (II)	**JA**	0.549**				
	JJ	0.455**				
	AA	0.609**				
Strength (III)	**JA**	0.074	-0.092			
	JJ	0.053	-0.443**			
	AA	-0.258*	-0.285*			
Salience (IV)	**JA**	0.400**	0.533**	0.190		
	JJ	0.537**	0.383**	0.143		
	AA	0.433**	0.413**	0.053		
Attractiveness (V)	**JA**	-0.310	-0.337**	0.416**	-0.047	
	JJ	-0.096	-0.524**	0.526**	0.031	
	AA	-0.247*	-0.571**	0.424**	-0.138	
Lower body fatness (VI)	**JA**	0.749**	0.437**	0.314**	0.475**	-0.072
	JJ	0.565**	0.020	0.406**	0.282**	0.195
	AA	0.521**	0.474**	-0.177	0.361**	-0.321

* Significant at the 0.05 level.
** Significant at the 0.01 level.

The 26-items Eating Attitudes Test (EAT) was developed by Garner, et al., (1982) as a screening tool to detect potential eating disordered patients. In this study the subjects' Eating Attitudes Test (EAT) scores and subscale scores were obtained and these results were then correlated with the scores from the BAQ and ABS questionnaires (Table 4.3.5). For all groups, the total BAQ score was moderately correlated with the EAT total score (r = 0.46-0.58) and was highly correlated with EAT dieting subscale (r = 0.61-0.75). By contrast, the ABS total score did not highly correlate with the EAT total score as much as BAQ did (r = 0.45-0.46). Correlations between BAQ and ABS for each study group ranged from 0.40-0.62. The results showed associations between BAQ and ABS total scores for all groups. In addition, the results show that a high BAQ total score may indicate a possible disordered eating of males.

Table 4.3.5 Correlations between BAQ and ABS scores with EAT scores

	Body Attitude Questionnaire (BAQ)			Attention to Body Shape Scale (ABS)		
	JA	JJ	AA	JA	JJ	AA
EAT-26 total score	0.459**	0.576**	0.572**	0.448**	0.454**	0.463**
Dieting subscale	0.613**	0.746**	0.710**	0.466**	0.459**	0.576**
Bulimia subscale	0.242*	0.477**	0.318**	0.279*	0.366**	0.269*
Oral control subscale	0.050	-0.011	0.013	0.178	0.143	0.002
BAQ total score	-	-	-	0.404**	0.617**	0.584**
Feeling fat	-	-	-	0.183	0.436**	0.347**
Disparagement	-	-	-	0.120	0.082	0.240*
Strength	-	-	-	0.425**	0.413**	0.282*
Salience	-	-	-	0.402**	0.590**	0.656**
Attractiveness	-	-	-	0.258*	0.321**	0.136
Lower body fatness	-	-	-	0.293*	0.345**	0.195
ABS total score	0.404**	0.617**	0.584**	-	-	-

* Significant at the 0.05 level.
** Significant at the 0.01 level.

Both BAQ and ABS questionnaires were developed using female subjects. The above results may indicate that these questionnaires can be used for males of different ethnic backgrounds. Acknowledging the results, scores from BAQ, ABS and EAT were listed below (Table 4.3.6). There were no differences in scores obtained from JA and JJ groups. Significant ethnic differences were found in 1) self-disparagement, 2) strength, 3) attractiveness, 4) lower body fatness BAQ subscales, and 5) EAT total scores. The Japanese expressed higher self-disparagement and lower body fatness subscale scores compared to Australian males. This indicates that Japanese males dissatisfied with their own body than Australian Caucasian males and the results were consistent regardless of their place of residence. By contrast the scores of the Australian subjects showed their confidence in their strength and attractiveness when compared to their Japanese counterparts. The EAT score was significantly higher among AA than both groups of Japanese males.

Table 4.3.6 BAQ, EAT, and ABS total scores and the BAQ and EAT subscale scores of study groups

	JA (n = 68) Mean ± SD	JJ (n = 84) Mean ± SD	AA (n = 72) Mean ± SD
BAQ total score	110.8 ± 17.0	109.5 ± 16.7	107.0 ± 14.8
Feeling fat*	33.6 ± 8.5	32.0 ± 9.4	29.3 ± 9.5
Disparagement*, **	17.2 ± 4.4	17.7 ± 4.0	13.2 ± 3.5
Strength*, **	17.4 ± 3.7	17.5 ± 4.3	21.1 ± 3.7
Salience	17.3 ± 3.7	17.4 ± 3.9	17.7 ± 4.0
Attractiveness*, **	14.2 ± 2.9	13.7 ± 3.4	17.5 ± 2.7
Lower body fatness*, **	11.0 ± 3.5	11.0 ± 2.7	8.2 ± 2.4
EAT total score*, **	45.7 ± 10.4	44.9 ± 10.1	50.7 ± 11.7
Dieting**	24.3 ± 6.7	23.2 ± 5.5	26.7 ± 8.1
Bulimia	8.4 ± 2.8	8.8 ± 3.6	9.5 ± 2.7
Oral control	13.2 ± 4.5	13.0 ± 4.9	14.5 ± 4.2
ABS total score	21.5 ± 4.1	20.9 ± 4.4	21.2 ± 4.8

* Significant difference between AA and JA at the 0.05 level.
** Significant difference between AA and JJ at the 0.05 level.

In order to determine the reliability of the questionnaires, 12 months test-retest reliabilities of all questionnaires were assessed using subjects who had completed baseline and 12 months assessments (ie, 60 JJ and 47 AA groups). Table 4.3.7 shows differences in questionnaire scores between the baseline and the follow-up assessments. Japanese males showed significant differences in the BAQ strength subscale (17.3 ± 3.7 at the baseline, 18.1 ± 3.1 at the follow-up) and the EAT bulimia subscale (8.4 ± 2.8 at the baseline, 7.4 ± 1.9 at the follow-up). Australian Caucasian males showed significant differences between the baseline and the follow-up assessments for the BAQ total scores, the BAQ lower body fatness subscale, and the EAT dieting subscale scores respectively. There were consistent differences between Japanese and Australian groups at both baseline and follow-up assessments. This may indicate that ethnic differences in scores obtained at the baseline were consistent between the assessments. Such differences in body concerns between ethnicity may contribute to a formation of their body image and also to a risk of developing body image related problems.

Table 4.3.7 Differences between the baseline and the follow-up scores of BAQ, ABS, and EAT (and subscales) of Japanese and Australian Caucasian males living in their home countries

	JJ (n = 60) Mean ± SD		AA (n = 47) Mean ± SD	
	Baseline	Follow-up	Baseline	Follow-up
BAQ total score	109.3 ± 14.7	111.3 ± 15.0	106.1 ± 14.7	110.0 ± 16.1*
Feeling fat	32.2 ± 9.0	32.7 ± 9.3	29.4 ± 9.7	31.0 ± 10.1
Disparagement#	17.8 ± 4.1	17.2 ± 3.8	13.2 ± 3.5	13.9 ± 4.1
Strength#	17.3 ± 3.7	18.1 ± 3.1*	20.6 ± 3.8	20.6 ± 4.3
Salience	17.2 ± 3.6	18.0 ± 3.6	17.7 ± 4.0	18.3 ± 4.3
Attractiveness#	13.6 ± 3.2	14.2 ± 2.7	17.1 ± 2.7	17.4 ± 2.9
Lower body fatness#	11.1 ± 2.6	11.2 ± 2.6	8.1 ± 2.3	8.8 ± 2.9*
EAT total score#	43.1 ± 7.8	42.3 ± 7.4	51.0 ± 11.7	52.8 ± 12.2
Dieting#	22.4 ± 4.6	22.3 ± 4.8	26.8 ± 8.2	28.6 ± 9.0*
Bulimia#	8.4 ± 2.8	7.4 ± 1.9*	9.7 ± 2.9	9.8 ± 2.6
Oral control	12.4 ± 4.7	12.6 ± 4.9	14.4 ± 4.3	14.4 ± 4.3
ABS total score	20.8 ± 3.9	21.6 ± 4.0	20.9 ± 4.9	21.0 ± 4.9

* Significant difference between the baseline and the follow-up at the 0.05 level.
\# Significant ethnic differences in follow-up scores at the 0.05 level.

4.3.4 Ethnic differences in body concern and body image

To determine causes of differences in the BAQ subscale scores and the EAT scores between Australian Caucasian males and Japanese males, their body concerns and general body image were compared using the results from the study questionnaire and the Somatomorphic Matrix computer program.

Table 4.3.8 represents responses on questions that asked about body concern-related behaviours. More Australian males compared themselves with males in the media than JJ group (p<0.05). Similarly, a larger proportion of the JA group compared themselves with Japanese models than JJ group (p<0.05).

Australian Caucasian males and Japanese living in Australia reported that they compare themselves with other ethnic individuals living in the same society.

However Japanese living in Japan were less likely to compare themselves with those around them. However, there was no difference in the proportion of subjects who were trying to achieve or to maintain the weight, which they perceived as “ideal”, between all groups. Regardless of study group, about 60% of each group were not trying to maintain their ideal weight. The response on a question asking their past dieting history was also not significantly different between groups. Significant ethnic differences were obtained with regards to a past history of supplement use for a diet purpose (p<0.05). A larger proportion of Australian Caucasian males reported that they used supplements for dieting purposes more frequently than Japanese males. However, it is important to acknowledge that 7% of JJ group and 1.5% of JA group decided not to respond this particular question, which may influence on a response of Japanese males living in Japan. For both Japanese and Australian males who responded “yes”, they reported that they used protein and creatinine supplements in order to gain weight.

Table 4.3.8 Body concern responses obtained from the study groups

Body concern	Questions	Response	JA (n=68) (%)	JJ (n=84) (%)	AA (n=72) (%)
	Frequency of comparing own physique with those in the media [B]	Always Sometimes Occasionally Seldom	2.9 23.5 22.1 51.5	0.0 16.7 25.0 58.3	9.7 29.2 27.8 33.3
	Frequency of comparing own physique with models of same ethnic group [B, C]	Always Sometimes Occasionally Seldom	5.9 14.7 23.5 55.9	0.0 9.5 17.9 72.6	8.3 15.3 30.6 45.8
	Frequency of comparing own physique with different ethnic groups on the street [A, C]	Always Sometimes Occasionally Seldom	13.2 19.1 26.5 41.2	0.0 7.1 28.6 65.3	1.4 18.1 25.0 55.6
	Maintaining ideal weight	Yes No	33.8 66.2	39.3 60.7	43.1 56.9
	Past diet experience	None To lose weight To gain weight Both to lose and gain	48.5 30.9 16.2 4.4	60.7 21.4 15.5 2.4	52.8 16.7 25.0 5.6
	Past experience of supplement usage for dieting purpose [A, B]	Yes No No comment	7.4 91.2 1.5	13.1 79.8 7.1	23.6 76.4 0.0

[A] = Significantly different between JA and AA at the 0.05 level.
[B] = Significantly different between JJ and AA at the 0.05 level.
[C] = Significantly different between JA and JJ at the 0.05 level.

Results of body perception using the SM program are shown in Table 4.3.9 and Figures 4.3.3 and 4.3.4. Body perception was assessed by comparing the values obtained from 1) the image of which they perceived as “my current” image (current), and 2) the image that perceived as most preferable image by females (ideal). Average values showed that males wished to gain more muscle and reduce body fat regardless of ethnicity. However, Figure 4.3.3 and 4.3.4 showed that those who perceived themselves as having a small amount of %BF or those who were less muscular, tend to select the physique that has greater %BF or greater muscularity as their ideal regardless of ethnicity. In addition, those who perceived themselves as having a large amount of %BF or muscularity selected the physique that has smaller %BF or muscularity value.

Table 4.3.9 Fatness# and muscularity## obtained from perceived "current" and "ideal" physiques using the SM program

	JA (n = 68) Mean ± SD	JJ (n = 84) Mean ± SD	AA (n = 72) Mean ± SD
%BF of "Current" physique	19.6 ± 7.9	17.7 ± 9.1	18.5 ± 8.5
%BF of "Ideal" physique	17.1 ± 5.6	16.4 ± 4.8	15.3 ± 6.2
%BF difference (Ideal – Current)	-2.5 ± 9.2	-1.3 ± 10.0	-3.2 ± 9.8
FFMI (kg/m^2) of "Current" physique	20.7 ± 2.6	20.7 ± 2.4*	20.7 ± 2.5*
FFMI (kg/m^2) of "Ideal" physique	23.2 ± 2.5	22.7 ± 1.9	22.8 ± 2.3
FFMI difference (Ideal – Current)	2.4 ± 3.2	2.0 ± 2.4	2.1 ± 2.8

* Significant difference between current and ideal FFMI values at the 0.05 levels.
# %BF was used as an indicator for fatness.
Fat Free Mass Index (FFMI) was used as an indicator for muscularity.

Figure 4.3.3 Scatter graph of perceived fatness with differences between perceived current and ideal body fatness using the SM program

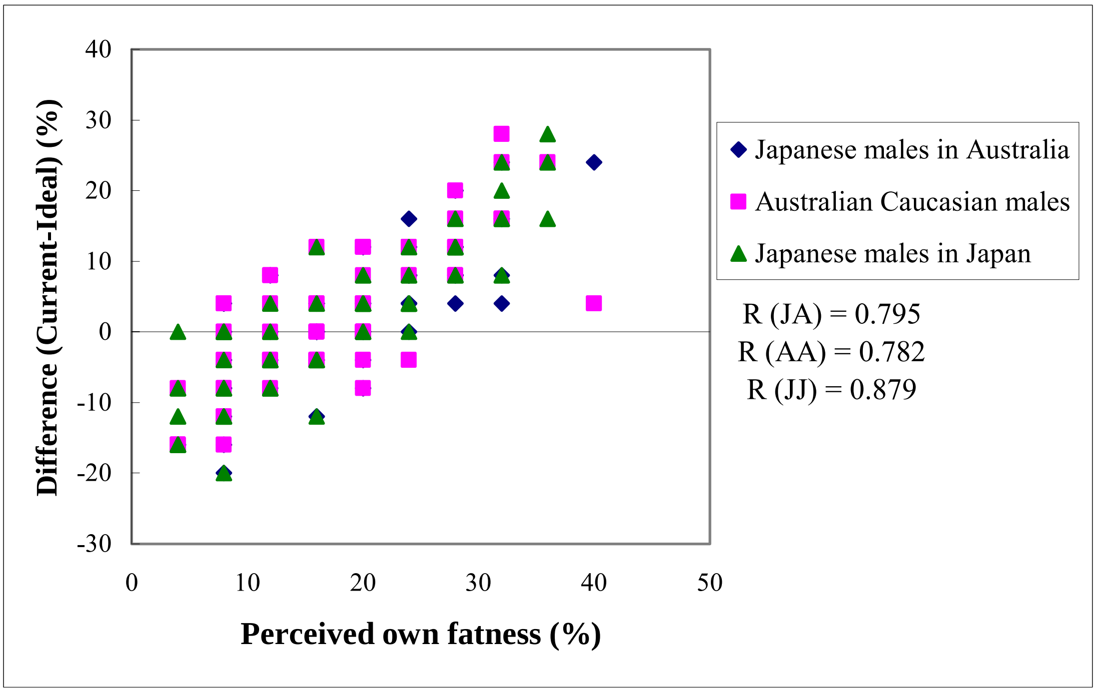
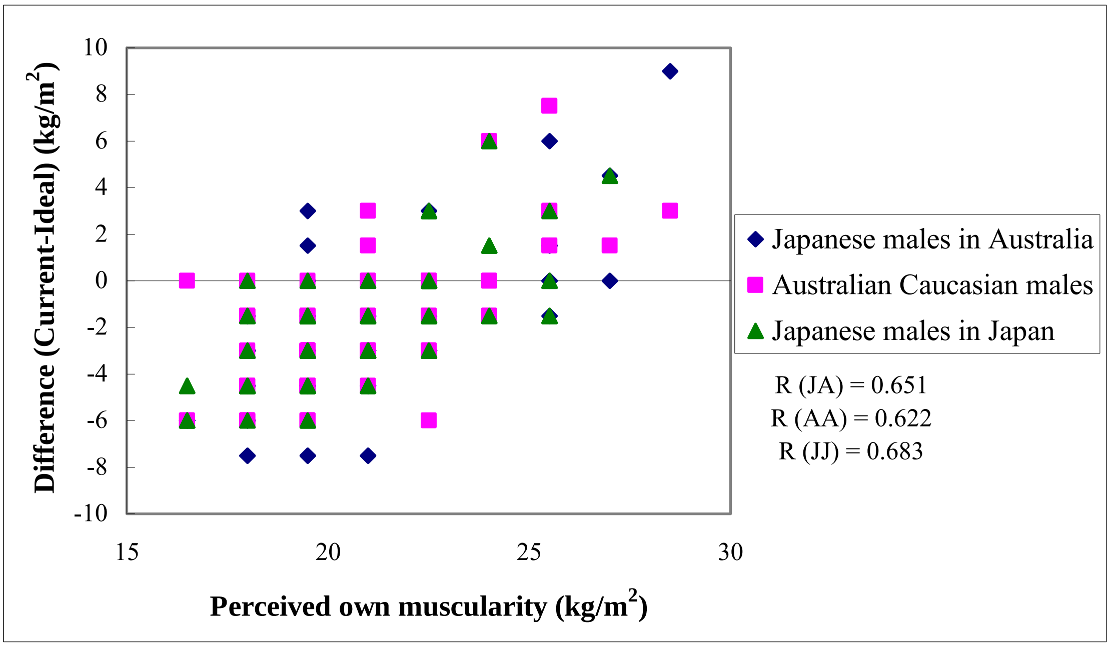


Figure 4.3.4 Scatter graph of perceived muscularity with differences between perceived current and ideal muscularity using the SM program



Using the SM program, body acceptability of the study groups was also assessed using the images that they perceived as upper and lower "acceptable limits" (ie, perceived "too thin" and "too fat") (Table 4.3.10). The results showed no group differences in body acceptability, even though study groups were expected to have different levels of exposure to different physiques in their daily life. Because of the wide variability between the body composition of the selected "current" image and the measured body composition values of subjects (see section 4.3.1) the body composition values shown in Table 4.3.9 and 4.3.10 may not be the true body composition values that they wish to have in the reality.

Table 4.3.10 Ethnic differences in body acceptability# using the SM program

	JA (n = 68) Mean ± SD	JJ (n = 84) Mean ± SD	AA (n = 72) Mean ± SD
Upper limit %BF (%)	28.0 ± 6.0	28.5 ± 5.5	28.3 ± 6.5
Lower limit %BF (%)	12.9 ± 5.2	11.6 ± 5.5	10.7 ± 6.9
%BF Acceptability (Upper-Lower)	15.1 ± 8.6	16.9 ± 7.7	17.6 ± 9.9
Upper limit FFMI (kg/m^2)	21.1 ± 2.7	21.4 ± 2.9	21.9 ± 3.0
Lower limit FFMI (kg/m^2)	19.7 ± 2.3	19.9 ± 2.2	20.2 ± 2.5
FFMI Acceptability (Too fat-Too thin)	1.4 ± 2.3	1.5 ± 3.0	1.7 ± 3.3

Body acceptability definition: The range of visual preferance of the human body that can be identified as "acceptable" (ie, not as "too thin" or "too fat").

4.3.5 Ethnic differences in body image in relation to body composition

The previous section described the subjective body image of the study groups. The weakness of subjective body image in research is a lack of studies that have linked body image with objective measures of body size, shape, and composition. The results reported in this section used data obtained from anthropometry as an objective measure and compared this to the body perception and a body satisfaction of Japanese and Australian Caucasian males in relation to their measured body composition variables.

Table 4.3.11 shows the body composition comparing the three groups of male subjects. Ethnic differences in body size were similar to the findings in the body composition section (Table 4.1.5). Australian males showed a significantly greater FFMI value, indicating a greater muscularity, their Japanese counterparts. In addition, in this specific study groups, JJ had significantly lower %BF than AA and JA groups. This may be associated with a difference in age between the JJ group and the other groups. Similarly, significant ethnic difference in sum of skinfolds between Australian (AA) and Japanese males (JA and JJ) was observed, even after adjustment for their height.

Table 4.3.11 Results of body composition assessment obtained by anthropometry

	JA (n =68) Mean ± SD	JJ (n =84) Mean ± SD	AA (n =72) Mean ± SD
Age (Years)	23.5 ± 2.9	20.5 ± 1.7$^{**, ***}$	23.1 ± 3.3
Stature (cm)	171.7 ± 5.1	172.9 ± 5.4	182.2 ± 7.2$^{*, **}$
Body mass (kg)	64.2 ± 7.6	64.0 ± 9.1	80.6 ± 11.9$^{*, *}$
Body Mass Index (kg/m^2)	21.8 ± 2.3	21.4 ± 2.8	24.3 ± 3.1$^{*, **}$
Waist Hip Ratio (WHR)	0.81 ± 0.04	0.79 ± 0.04$^{**, ***}$	0.82 ± 0.04
Total Body Fat (%BF)	17.0 ± 5.1	16.5 ± 5.1**	19.1 ± 6.0
Sum of 8 skinfolds (mm)	81.8 ± 33.6	79.6 ± 37.9	106.5 ± 47.1$^{*, **}$
Ht-corrected sum of 8 skinfolds	81.2 ± 33.8	78.3 ± 36.7	99.4 ± 44.0$^{*, **}$
Fat Free Mass Index (kg/m^2)	18.2 ± 1.3	17.9 ± 1.6	19.4 ± 1.6$^{*, **}$

* Significant difference between AA and JA at the 0.05 level.
** Significant difference between AA and JJ at the 0.05 level.
*** Significant difference between JA and JJ at the 0.05 level.

Using the SM program, every subject was asked to rate how much he was satisfied with his current physique. Body satisfaction rating from the SM program was assessed in relation to the measured body composition obtained from anthropometry (Table 4.3.12). Results showed that satisfaction did not correlate strongly with the body composition variables. For the AA group, the sum of skinfolds was the variable that showed the strongest association (r = -0.390) with their body satisfaction, followed by the WHR, %BF, the BMI, and waist girth. Similarly, the JA group showed the strongest association with %BF (r = -0.313), followed by the sum of skinfolds and the BMI. In comparison with the groups living in Australia, the JJ group did not show any correlation between their satisfaction responses and their measured anthropometric variables.

Table 4.3.12 Correlation between body satisfaction and selected anthropometry variables

	Body satisfaction		
	JA (n =68)	JJ (n = 84)	AA (n = 72)
Percent body fat (%BF)	-0.313**	-0.160	-0.332**
Sum of skinfolds (mm)	-0.301*	-0.178	-0.390**
Weight	-0.196	-0.085	-0.140
BMI	-0.271*	-0.107	-0.267*
WHR	-0.136	-0.083	-0.355**
Waist girth	-0.207	-0.144	-0.249*
Gluteal girths	-0.178	-0.133	-0.070
Biacromial	0.098	0.184	-0.055
Biiliocristal	0.081	-0.094	0.023
Femur	-0.296*	-0.052	0.122

* Significant at the 0.05 level.
** Significant at the 0.01 level.

Correlations between body satisfaction and anthropometric measurements were also assessed using the BAQ self-disparaging and attractiveness subscales, subscales that showed significant ethnic differences (Table 4.3.13). While the BAQ total score correlated with some anthropometric variables, both self-disparaging and attractiveness subscales did not show strong correlations with measured body composition variables. From the results shown in Table 4.3.12 and 4.3.13, it can be suggested that the level of body satisfaction possessed by both Japanese and Australian Caucasian males is not based on their actual body composition and or anthropometric measurements.

Table 4.3.13 Correlations between the BAQ total score, disparaging and attractiveness subscale scores with selected anthropometric variables

	JA (n =68)			JJ (n = 84)			AA (n = 72)		
	BAQ-T	BAQ-S	BAQ-A	BAQ-T	BAQ-S	BAQ-A	BAQ-T	BAQ-S	BAQ-A
Percent body fat (%BF)	0.553**	0.298*	-0.088	0.506**	0.191	-0.043	0.369**	0.166	0.070
Sum of skinfolds (mm)	0.536**	0.295*	-0.123	0.473**	0.209	-0.068	0.376**	0.198	0.086
Weight	0.503**	0.165	-0.092	0.591**	0.029	0.090	0.450**	0.065	0.169
BMI	0.553**	0.169	-0.088	0.604**	0.072	0.065	0.530**	0.201	0.145
WHR	0.274*	0.127	0.015	0.335**	0.135	-0.036	0.301*	0.197	-0.015
FFMI	0.337**	-0.016	-0.046	0.506**	-0.050	0.139	0.460**	0.090	0.200
Waist girth	0.549**	0.240*	-0.034	0.570**	0.117	0.017	0.421**	0.125	0.118
Gluteal girths	0.546**	0.231	-0.059	0.559**	0.052	0.065	0.380**	0.019	0.196
Biacromial	0.003	-0.051	-0.025	0.313**	-0.141	0.314**	0.131	-0.117	0.229
Biiliocristal	0.070	0.015	-0.108	0.261*	-0.055	0.092	0.205	0.008	0.095
Humerus	0.124	-0.008	-0.066	0.352**	-0.174	0.292**	0.035	-0.256*	0.222
Femur	0.384**	0.185	-0.280*	0.446**	-0.089	0.124	0.118	-0.042	0.114

* Significant at the 0.05 level.
** Significant at the 0.01 level.
BAQ-T = The BAQ total score, BAQ-S = The BAQ self-disparaging subscale score, BAQ-A = The BAQ attractiveness subscale score.

Each subjects' perception of their own body weight was recorded. The results are summarised for each group in Table 4.3.14. The Japanese males significantly overestimated their own weight compared with the actual measured value (p<0.05). Their perceived "ideal" weight for their perceived current stature was however, equivalent to the measured values.

Differences between measured body weight and their perceived "current" and "ideal" body weights are illustrated as scatter plots. The AA group and the JA group showed wider discrepancies between their perceived and measured body weight than that of the JJ group in their perceived own body weight compared with the JJ group (Figure 4.3.5). While Table 4.3.14 did not show significant differences between measured and ideal weight, Figure 4.3.5 showed a wide discrepancy of approximately ±6kg in their perceived current and measured weight. Figure 4.3.6 also shows that males with small body weight wished to gain weight, whereas those who are heavier want to lose weight.

Table 4.3.14 Difference between measure, perceived, and ideal body mass

	JA (n =68) Mean ± SD	JJ (n =84) Mean ± SD	AA (n =72) Mean ± SD
Measured weight (kg)	64.2 ± 7.6	64.0 ± 9.1	80.6 ± 11.9*
Perceived current weight (kg)	64.9 ± 7.7#	64.4 ± 9.2#	80.3 ± 12.1*
Ideal weight (kg)	63.9 ± 6.3	64.6 ± 6.0	79.5 ± 8.2*

Significant difference between "measured" body mass and "perceived" body mass at the 0.05 level.
* Significant difference between Australian Caucasians and Japanese groups at the 0.05 level.

Figure 4.3.5 Scatter graph of body weight with differences between measured and perceived body weight of the study groups

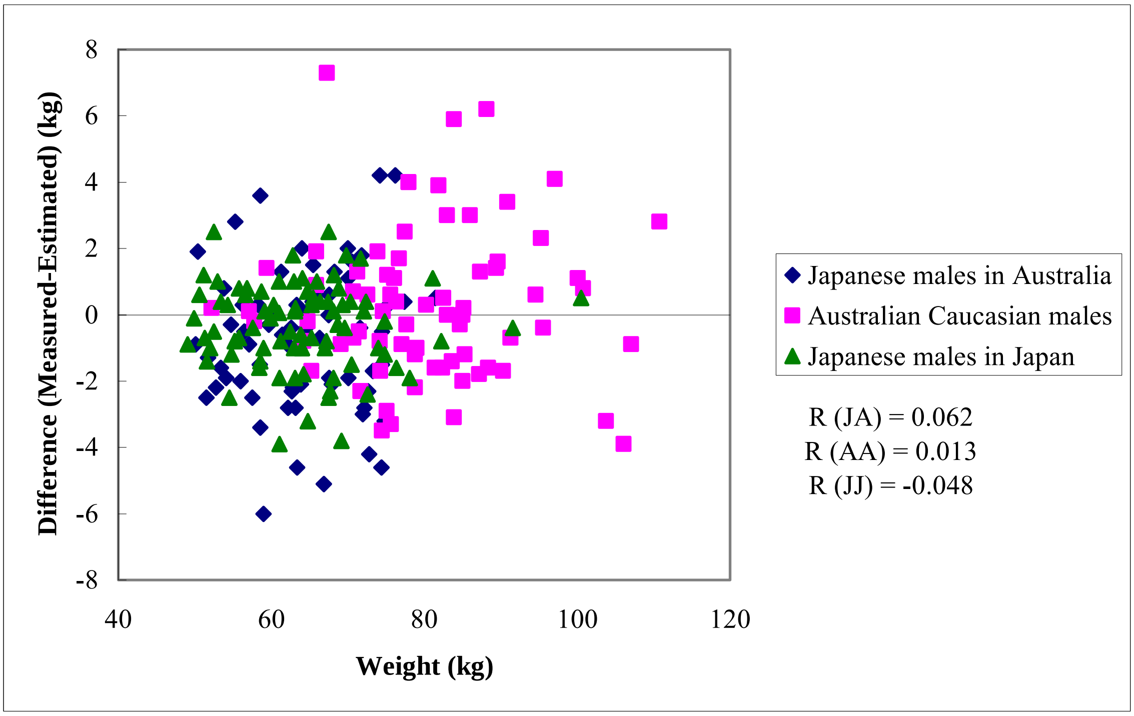
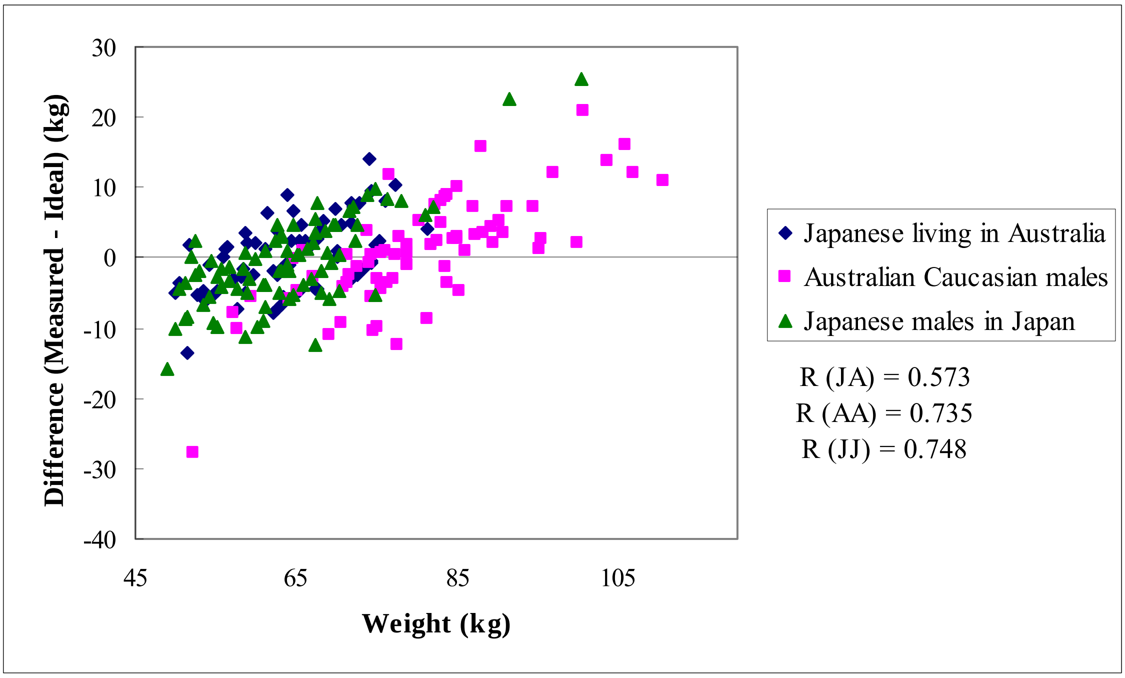


Figure 4.3.6 Scatter graph of body weight with differences between measured and ideal body weight of the study groups



A Kappa analysis was conducted to assess the level of agreement between 1) BMI and perceived "heaviness", 2) BMI and perceived "fatness", 3) %BF and perceived "fatness", and 4) sum of skinfolds and perceived "fatness" to examine how they perceive themselves by taking their body composition into account.

The respondents were asked two questions about their perceptions of the body. First question was about how heavy they thought they were and the body perceptions obtained from this question were classified as "light", "average weight", and "heavy". The second question asked about their perceived total body fatness and this was classified as "small amount", "average amount", and "large amount" of body fat. These perceived responses were then compared with the following objective measurements. For classification of "heaviness", the BMI classification of the WHO was used for Australian Caucasian males and the classification for the Asia-Pacific population was used for Japanese males (see Table 2.2 for details of classifications) as these reflect body fatness of each ethnic group. Classification of "fatness" was made by %BF and sum of skinfolds. For %BF, a range of 10-20% was used as "average" for both ethnic groups as similar levels of %BF classifications were proposed in Japan and also in the West (see Table 3.6 for proposed %BF cut-off values). For skinfolds, cut-off points for sum of skinfolds (ie, <33%, 33-66%,

>66%) was determined using the samples reported in the Result Section 4.1.3 and subjects of each study group were classified as having "small amount", "average amount", and "large amount" of body fat. The cut-off points of sum of skinfolds to divide the sample into three equal groups are shown in Table 4.3.15.

Table 4.3.15 Cut-off points using the sum of skinfolds for each study group

	Cut-off points (mm)	
	33.3 percentile	**66.7 percentile**
JA (n = 145)	59.35	80.37
JJ (n = 84)	62.40	80.40
AA (n = 143)	66.30	97.80

After the exclusion of subjects who responded as "I don't know", Table 4.3.16 shows a high level of agreement between BMI and perceived "heaviness" for all study groups. Poor agreement was obtained between %BF and perceived "fatness". Weighted Kappa was conducted to assess agreements of following (Figure 4.3.7):

1) Perceived "heaviness" to the BMI, and
2) Perceived "fatness" to %BF,
3) Perceived "fatness" to sum of skinfolds

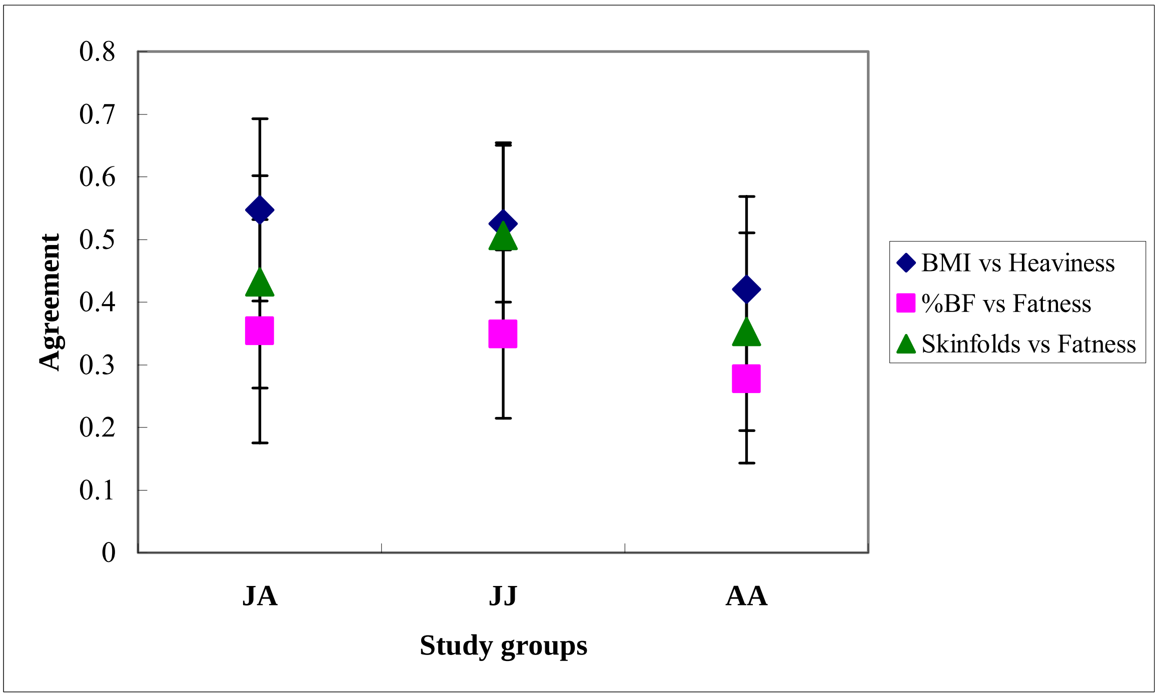
The results indicate that all groups have relatively close agreement between their body mass and how heavy they perceived themselves to be. By contrast, they did not show a good agreement between their perception of own fatness and their total body fatness (ie, %BF). Among the study groups however, the JJ group showed an agreement between the sum of skinfolds and their perception of their own "fatness" that was similar to the agreement between the BMI and their perceived "heaviness".

Table 4.3.16 Kappa results* of body perceptions in relation the BMI and %BF

	JA	**JJ**	**AA**
BMI & "heaviness"#	0.476	0.443	0.376
BMI & "fatness"##	0.374	0.375	0.295
%BF & "fatness"###	0.344	0.264	0.239
Sum of skinfolds & "fatness" ###	0.330	0.407	0.314

* Kappa values 0.21-0.40 = Fair, 0.41-0.60 = Moderate agreement.
# JA = 66, JJ = 83, AA = 72, ## JA = 65, JJ = 80, AA = 70, ### JA = 65, JJ = 81, AA = 70

Figure 4.3.7 Differences in weighted Kappa results between perceived "heaviness" and "fatness" in relation to the BMI and %BF



Differences in how subjects perceived their body composition relative to their measured body composition are shown in Figures 4.3.8 and 4.3.9. About 15% of Japanese males who have BMIs classified as "average" think of themselves as "heavy", compared to only 6.7% of Australians. Similarly, with perceptions of "fatness", approximately 20% of JA and JJ subjects who are in "average" classification (see Table 3.6 for the %BF values used for this comparison) of %BF perceived themselves as being fat. However, only 4.8% of AA of the same category of %BF perceived themselves as being fat.

The proportion of over-concerned Japanese subjects with "average" amount of fatness increased when the sum of skinfolds was used as an indicator for "fatness". This could be because amount of subcutaneous adipose tissue is easily acknowledged by subjects and the amount of subcutaneous fat may unnecessarily increase concern toward their own level of fatness. Further, 50% of the JA subjects whose sum of skinfolds was categorised in the lower third cut-off point perceived as they have "average" amount of body fat. In comparison with the results by the JA group, the JJ individuals with the lower third skinfold cut-off point did not show same pattern. Hence there is a possibility that the JA subjects were more concerned about their level of fatness than the JJ subjects (ie, greater distorted body perception).

By contrast, more than 30% and 50% of Australian Caucasian males whose BMI and %BF were in "overweight" categories perceived themselves as "not heavy" or "not fat". The results showed that the AA subjects also failed to perceive themselves correctly in relation to their body composition. While most of JA (89.5%) and JJ (100.0%) subjects, who were classified as overweight by the BMI classification, perceived themselves as "heavy", only 65.4% of the AA subjects perceived themselves as they are being "heavy" (Figure 4.3.8). Similarly, only 38% to 47% of the AA subjects who were classified as "overweight", using sum of skinfolds and %BF respectively, perceived themselves as being "fat". By comparison, at least 65.4% of Japanese groups who were classified as overweight perceived themselves as "overweight". These results indicate that Australian Caucasian males are more optimistic whereas Japanese males had a pessimistic perception about their own body composition.

Figure 4.3.8 Proportion of subjects with correct body perception in relation to their heaviness using the BMI as an indicator of heaviness

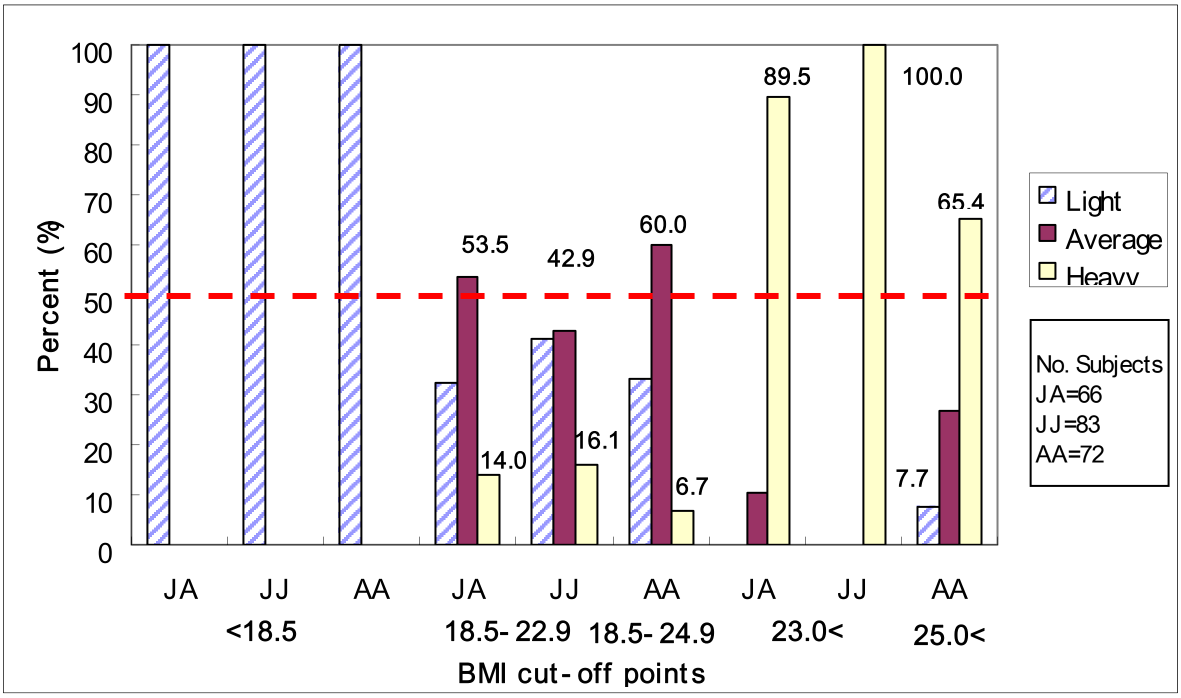
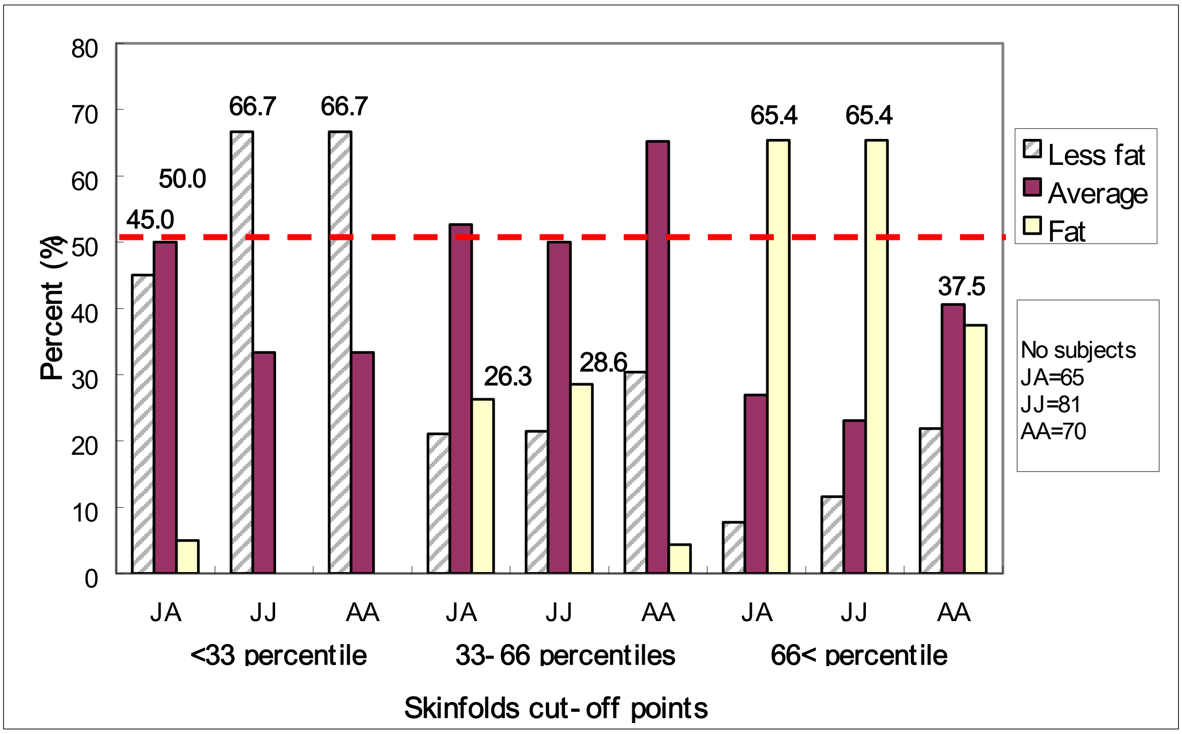
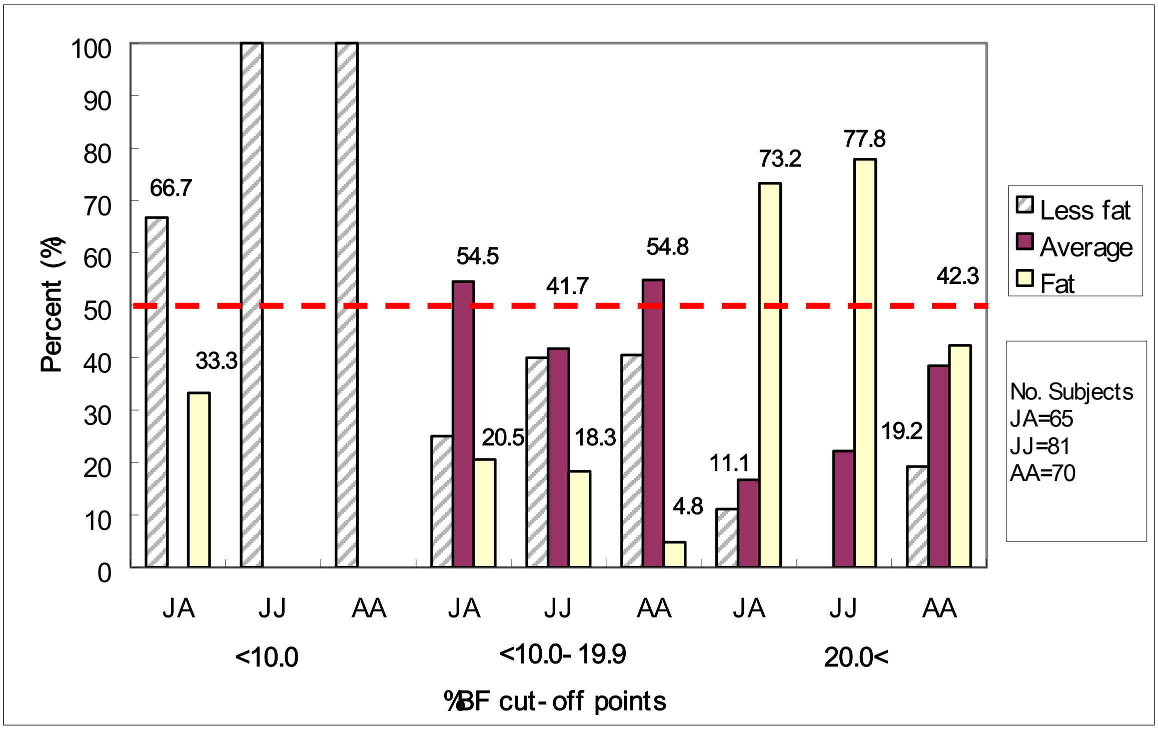


Figure 4.3.9 Proportion of subjects with correct body perception in relation to their fatness using a) sum of skinfolds, and b) %BF obtained from anthropometry as an indicator of fatness

a) Sum of skinfolds and perceived "fatness"



b) %BF and perceived "fatness"



4.3.6 Associations of anthropometric variables to EAT and BAQ scores

The results in Figures 4.3.8 and 4.3.9 showed that Japanese males were more likely to perceive themselves as "fat" or "heavy" than the Australian males. By contrast, Australian Caucasian males were more likely to perceive themselves as "not fat" or "not heavy". Australian males showed higher EAT scores than Japanese males, indicating a potentially higher risk of developing disordered eating. Ethnic differences in association between obtained EAT scores and anthropometric variables were assessed in this section. While the EAT is a questionnaire to assess the risk of disordered eating, the BAQ is a questionnaire to assess body attitudes. There were no differences in the obtained BAQ and ABS scores from all study groups (JA: 110.8 ± 17.0, JJ: 109.5 ± 16.7, and AA: 107.0 ± 14.8 respectively for the BAQ, JA: 21.5 ± 4.1, JJ: 20.9 ± 4.4, and AA: 21.2 ± 4.8 respectively for the ABS). Scores from both the BAQ and the ABS were used to determine differences in correlations with anthropometric variables and compared the results with the correlations between anthropometric variables and the EAT total score.

Table 4.3.17 shows correlations between selected anthropometric variables and the total scores obtained from the EAT, the BAQ, and the ABS. Anthropometric variables of all study groups were significantly correlated with the BAQ total score. The BMI (r = 0.621-0.554), body mass (r = 0.617-0.476), and %BF (r = 0.522-0.431) showed highest correlations among all anthropometric variables examined. For the EAT total score, the AA group did not show any correlation with anthropometric variables. Among Japanese groups, the JJ showed correlations between their EAT scores with all anthropometric variables but no correlations were observed for the JA group. The ABS total score was correlated with body mass, the BMI, the FFMI and %BF for the JJ group and with FFMI for the AA group. These correlations were however weak, ranged from 0.220 and 0.269.

Table 4.3.17 Spearman's correlations between the EAT and the BAQ total scores with anthropometric variables

	EAT			BAQ			ABS		
	JA (n=68)	JJ (n=84)	AA (n=72)	JA (n=68)	JJ (n=84)	AA (n=72)	JA (n=68)	JJ (n=84)	AA (n=72)
Body mass	-0.054	0.348**	0.064	0.498**	0.617**	0.476**	0.155	0.220*	0.143
BMI	0.009	0.351**	-0.013	0.556**	0.621**	0.554**	0.193	0.269*	0.171
Sum skinfolds	-0.092	0.329**	0.025	0.517**	0.509**	0.435**	0.053	0.207	0.019
WHR	0.164	0.267**	-0.108	0.253*	0.369**	0.312**	0.150	0.185	-0.077
%BF	-0.064	0.328**	-0.033	0.533**	0.522**	0.431**	0.076	0.224*	0.023
FFMI	-0.046	0.261*	-0.021	0.346**	0.519**	0.456**	0.166	0.256*	0.242*
BMI-BMI$_{Ideal}$	0.002	0.273*	0.177	0.383**	0.493**	0.605**	-0.005	0.021	0.085

* Significant at the 0.05 level.
** Significant at the 0.01 level.

The JJ group showed greater correlations between anthropometric variables and all questionnaires (ie, the EAT, the BAQ, and the ABS) than the JA and the AA groups. As EAT is a screening tool for disordered eating and consists of three subscales, correlations between anthropometric variables and each subscale were also examined (Table 4.3.18). Among the subscales of the EAT, the dieting subscale showed a stronger relationship to the anthropometrical variables of the JJ group. All three groups showed a significant correlation between the dieting subscale score and a difference between their measured BMI and perceived "ideal" BMI (JA: 0.342, JJ: 0.577, AA: 0.372). While JJ subjects showed correlations between the bulimia subscale and anthropometric variables, both the JA and the AA groups showed significant correlations between the oral control subscale and body mass (JA: -0.394, AA: -0.247), the BMI (JA: -0.328, AA: -0.342), and the FFMI (JA: -0.331, AA: -0.334).

Table 4.3.18 Spearman's correlations between the EAT subscales and anthropometric variables of the study groups

	Dieting			Bulimia			Oral control		
	JA (n=68)	JJ (n=84)	AA (n=72)	JA (n=68)	JJ (n=84)	AA (n=72)	JA (n=68)	JJ (n=84)	AA (n=72)
Body mass	0.297*	0.636**	0.221	-0.032	0.273*	0.105	-0.394**	-0.162	-0.247*
BMI	0.361**	0.676**	0.238*	0.002	0.210*	0.022	-0.328**	-0.129	-0.342**
Sum skinfolds	0.265*	0.569**	0.201	-0.150	0.152	-0.029	-0.285	-0.050	-0.140
WHR	0.340**	0.343**	0.042	0.034	0.196**	-0.166	0.016	-0.016	-0.219
%BF	0.283*	0.560**	0.160	-0.116	0.159	-0.084	-0.272	-0.039	-0.182
FFMI	0.236	0.534**	0.239*	0.021	0.192*	0.091	-0.331**	-0.109	-0.334**
BMI-BMI_{Ideal}	0.342**	0.577**	0.372**	-0.072	0.084	0.084	-0.286*	-0.139	-0.158

* Significant at the 0.05 level.
** Significant at the 0.01 level.

All groups showed a significant correlation between the dieting subscale and the difference between measured and perceived "ideal" BMI, indicating that a discrepancy between current and ideal weight has a strong influence on dieting behaviours regardless of ethnic background. Apart from the impact of discrepancy between "current" and "ideal" BMI values to dieting behaviours, the following anthropometric variables were examined to determine any association with the dieting subscale score of the EAT questionnaire:

Independent variables-

1) 'Body mass',

2) 'Sum of skinfolds',
3) 'WHR',
4) '%BF', and
5) 'FFMI'

Dependent variable-
1) EAT dieting subscale score

As the BMI is a proportion between stature and body mass and therefore co-correlated with body mass, the BMI was excluded from the equation.

Table 4.3.19 Prediction equations for the dieting subscale score using anthropometric variables as an independent variable

Groups	Equation	R^2	SEE
JA	$y = 24.17 + 0.893(BMI\text{-}BMI_{ideal})$	0.061	6.40
JJ	$y = 7.657 + 0.701(BMI\text{-}BMI_{ideal}) + 0.244(\text{Body mass})$	0.400	4.33
AA	$y = 26.398 + 1.192(BMI\text{-}BMI_{ideal})$	0.121	7.66

The results shown in Table 4.3.19 suggest that while the discrepancy between their current BMI and ideal BMI is the major contributing factor of dieting behaviours for JA and the AA groups, absolute (measured) body mass is also a strong contributing factor for the JJ group.

In addition, while they showed a moderate correlation with %BF (r = 0.560) and sum of skinfolds (r = 0.569), a similar level of correlation was also obtained from the FFMI (r = 0.534). These results may support an assumption that the JJ subjects are likely to commence dieting from their body mass but have no clear idea of what components actually construct their body mass. The anthropometric variables of the JJ group are more associated with the EAT subscale score than in the other sample groups. For this reason the JJ group may possibly be at a higher risk of developing disordered eating from possessing an incorrect body perception.

4.3.7 Summary

In this section of the results chapter the following issues have been discussed:

1. Measured body composition values of subjects were compared with the body composition value of the “current (own)” image that each participant selected from the Somatomorphic Matrix computer program (SM). The results showed that majority of Japanese and Australian males did not select an image from the SM program which reflected their actual body composition as measured by DXA. The huge variability for each body composition value indicates its inappropriateness to accept the values as comparable to values from actual body composition assessment methods.
2. The Ben-Tovim Walker Body Attitudes Questionnaire (BAQ) and the Attention to the Body Shape Scale (ABS) showed good validity and test-retest reliability for both Japanese males. Australian Caucasian males also showed good validity and reliability for the ABS and validity for the BAQ. However, BAQ scores of Australian Caucasian males obtained at the baseline and the 12-months assessments were significantly different. Japanese males had high self-disparagement scores and were concern about attaining lower body fatness than Australian males. By contrast, Australian males showed more confidence in their strengths and attractiveness than their Japanese counterparts. In addition, Australian Caucasian males showed higher Eating Attitudes Test (EAT) total score as well as dieting subscale score than Japanese counterparts.
3. Australian males and Japanese males living in Australia are likely to compare their own physiques with the physiques of other people, including those in the media and people on the street, more frequently than Japanese living in Japan. There was no significant difference in past dieting behaviours between any of the study groups, but Australian males reported more frequent use of diet supplements, such as protein and creatinine. These supplements were usually taken to gain muscle mass. Therefore the results may indicate a greater effort to gain muscle mass by Australian Caucasian males than Japanese males.
4. Japanese and Australian males living in their home countries selected a more muscular image as their “ideal” image. The JA group did not show a significant difference between their perceived “current” and “ideal” physiques. No ethnic

and environmental influence was observed in body acceptability. In addition, body satisfaction was not associated strongly with anthropometric variables.

5. Japanese males showed overestimation in their perception toward themselves, whereas Australian Caucasian males underestimate themselves. Both ethnic groups showed moderate agreement between the BMI and their perceived "heaviness" but poor understanding in their %BF and their perception of "fatness".
6. Among the study groups, the JJ group had higher EAT scores with increasing anthropometric variables. Body mass was found to be a strong contributor that triggers dieting behaviours of Japanese living in Japan, regardless of their actual body composition such as %BF and FFMI. A distorted body perception of their actual body composition and preoccupation toward the body mass may increase a risk to commit unnecessary weight-control behaviours among the JJ subjects.

Chapter 5 - Discussion

Part I. Body composition

5.1 Selection of an appropriate body density prediction equation for Japanese and Australian Caucasian young males

In Japan, the body density prediction equation that has been most frequently used is the 'Nagamine and Suzuki (a) (1964)' equation. This equation was developed 40 years ago and it is still in wide spread usage to calculate body density and hence %BF. While it has been suggested that this equation is inappropriate for the current Japanese population (Komiya & Nakao 2002), there have been no reported studies that have actually tested its current validity. This study aimed to determine the appropriateness of Japanese prediction equations in current use when applied to Japanese males living in a foreign country. Using the DXA scan as the criterion method, the current study showed a significant underestimation of %BF when the 'Nagamine and Suzuki (a)' equation is used to estimate body fat from anthropometry. The degree of underestimation increased with increasing measured %BF values. The anthropometric equation that showed the least difference with the DXA scan results was the 'Durnin and Womersley' (1974) equation for both study groups.

All existing body density prediction equations are population specific. Also each equation was developed using different methodologies, and varying in equipment and measurement sites. These differences in methodology may introduce errors when applying the equation to the different population groups or to the original population if has undergone secular trend and the population characteristics have changed. With regards to variation in equipment, Schmidt and Carter (1990) examined dial accuracy, downscale force, and pressure of five different types of skinfold calipers (Harpenden, Lange, Slim Guide, Skyndex, and Lafayette) at different jaw openings (10, 20, 30, 40, and 50 mm). They found that, after eliminating the measurer error, Harpenden, Slim Guide, and Skyndex calipers give similar results, but the values are lower than the other two calipers, the amount depending on the compressed thickness. To minimise errors that could be introduced from differences in methodology and sample characteristics, it is important to select the prediction equations that were developed from subjects of similar characteristics using similar equipments. In this study current four body density prediction equations were used:

1) Durnin and Womersley (1974),
2) Withers, et al. (1987),
3) Nagamine and Suzuki (1964a), and
4) Nagamine and Suzuki (1964b).

All equations were originally developed from sample populations of males which included the age range of the current study group. The 'Durnin and Womersley' and the 'Withers, et al.' equations were developed using Harpenden skinfold calipers. While the first two equations did not specify the ethnicity of study groups that were used in their development, it is assumed that they were Caucasian. The 'Nagamine and Suzuki' equations were developed specifically using data from Japanese males. The 'Nagamine and Suzuki' equations, however, were developed using a different type of skinfold calliper, the Minnesota calliper. Because the jaw pressure of this caliper is, however, the same as the Harpenden caliper ie, 10g per mm^{-2}, it is most likely that the Harpenden and Minnesota calipers give similar results. In this study the Harpenden caliper was used and the methods conformed to internationally accepted practice. The results from this study could therefore be used to evaluate existing body density prediction equations.

Among these body density prediction equations, the current study showed the 'Durnin and Womersley' equation was the only equation that showed equivalent total body fat values to the results obtained from DXA. There are several factors that could explain inappropriateness of other equations.

The 'Withers, et al. (1987)' body density prediction equation was derived from an assessment of elite male athletes. In comparison, the 'Durnin and Womersley' equation was developed a sample of individuals who represented a variety of body types. The subjects involved in the current study were not elite athletes but were "average" young adults, similar to those who were involved in the development study of the 'Durnin and Womersley' equation. It is likely that the major variable that caused the large differences from the measured body composition by the DXA scan and anthropometry (using the prediction equations) was the level of physical activity.

There are a number of possible explanations of the inappropriateness of the 'Nagamine and Suzuki' equations for Japanese living in Australia. First, the equations were developed as linear regression equations. However, as suggested elsewhere (Jackson & Pollock 1978), the relationship between skinfold fat and body density is quadratic rather than a linear. Hence the application of a linear regression equation could introduce an error in predictions of individuals who were located at extremities of the distribution. By contrast, the 'Durnin and Womersley' equation is a linear, but log transformed regression model. The log conversion has the effect of changing the quadratic relationship between body density and the sum of skinfolds into a linear relationship, which may improve estimations of body density across a wider spectrum of results (Jackson & Pollock 1978).

One other possibility for the differences is the secular trend in body composition and physique among Japanese population. Compared with the time the prediction equation was developed (three decades ago), the body size of Japanese has changed for both genders. Between 1964 and 1998, the average height of Japanese males aged 22 (the mean age of subjects in the Nagamine and Suzuki study) increased from 163.7cm to 169.5cm and from 164.1cm to 170.3cm for 24 year olds (mean age for this study). Their body mass also increased from 56.0kg to 65.4kg for 22 year old Japanese males and 57.1kg to 65.7kg for 24 year old (KEJK & ECKH 1998; KEJK 2000). While there are no published studies that have reported a change of body composition during a period of 1964 and 1998, the increase in body size probably indicates changes in actual body composition, such as muscularity, body fatness or subcutaneous fat distribution. These changes in body composition are likely to be associated with the transition of Japanese lifestyle, including diet and exercise patterns, from the traditional style to a more Westernised lifestyle. The transition includes the increased energy, protein and fat intakes, which have occurred since the end of World War II (KEJK & ECKH 1998).

The current study has shown that the body density prediction equation of Nagamine and Suzuki is no longer applicable to contemporary young male Japanese populations. This study was undertaken on a Japanese sample living in Australia and as most of them had lived in Australia for only a short period of time, it is most likely that the results would apply equally to Japanese resident in Japan. However to confirm these results it is recommended that the study should be replicated using Japanese males living in Japan.

The use of body density and body fat prediction equations is always associated with a degree of prediction error. It is obviously important to validate and then use equations that minimise error. While a previous study stated that the use of different body fat prediction equations (ie, Siri and Brozek's equations) caused non-significant differences in estimated values (Durnin & Womersley 1974), results from the current study have found that this is not always the case. For the 'Withers, et al.' and the 'Nagamine and Suzuki (a)' equations, significant differences in predicted body fat values were observed, dependent on the specific body fat prediction equation used. Brozek's %BF prediction equation has been commonly used in Japanese body composition studies (Nagamine & Suzuki 1964; Suzuki & Tatsumi 1993; Tahara et al. 1993c; Yoshinaga et al. 2002). Hattori (1991) suggested that there is no study comparing estimated values from Siri and Brozek's equation for adult population. The current study found that the Brozek's equation predicts slightly but significantly smaller %BF than the Siri's equation using Nagmine and Suzuki (a) equation. Considering the frequent use of Brozek's equation in Japanese body composition studies, there is a possibility that previous Japanese studies using the 'Nagamine and Suzuki (a)' equation with Brozek's equation underestimated the %BF of Japanese subjects.

The calculation of body density followed by its conversion into %BF values involves a risk of prediction error. To reduce unnecessary prediction error from the conversion of predicted body density to a percent body fat value, it is useful to establish body fat prediction equations that do not require the combination of body density and body fat prediction equations. The current study proposed %BF prediction equations using individual skinfold sites, sum of seven skinfolds, sum of eight skinfolds and also height-corrected sum of eight skinfolds. For each ethnic group, the prediction equation that showed the strongest correlation between the body fat value obtained from the DXA scan and anthropometric variables was the one which used individual skinfold sites (Japanese: r^2 = 0.786, SEE = 2.691, Australian: r^2 = 0.864, SEE = 2.373), followed by the sum of eight skinfolds (Japanese: r^2 = 0.714, SEE = 3.071, Australian: r^2 = 0.847, SEE = 2.449). There was no influence of ethnicity in %BF prediction using a set of independent skinfold sites. Similarly, no influence of ethnicity was observed when height-correct sum of skinfolds was used to predict %BF of Japanese and Australian Caucasian males. This could be due to no significant differences in skinfold thickness except for a medical calf skinfold and a similarity in their somatotype (Japanese: 2.7-4.6-3.1, Australian: 2.7-5.0-2.8) of the study groups (see 3.3.3 of Methodology Chapter for explanation of somatotype notation). This may indicate the possibility of predicting body fat of Japanese and Australian Caucasian males living in Australia using one single prediction equation, as there was a similarity in their body composition between Japanese and Australian Caucasian males examined. This result suggests that the physique of Japanese has changed to be more like Western populations and possibly explains the reason that their %BF values were predicted effectively using the ‘Durnin and Womersley’ body density prediction equation.

The use of the modified body fat prediction equation using anthropometric variables, which were developed in this study, would assist in the reduction of prediction errors in future studies of Japanese populations. However before these equations are more widely adopted, it would be prudent to undertake further studies, using larger sample sizes, to confirm their applicability to both Japanese and Australian Caucasian males.

5.2 Ethnic differences in body composition and the BMI-%BF relationship

The ethnic differences in body composition of Australian Caucasian males and Japanese males were obtained using detailed anthropometry. The results however, showed no major differences between the Japanese groups who were living in Japan and Australia. Australian Caucasian males were taller, heavier, and had higher BMI values than their Japanese counterparts. In addition, their mean somatotype indicated that Australian males (3.1-5.4-2.5) were more mesomorphic, but less ectomorphic, than their Japanese counterparts (3.0-4.9-2.8 for JA and 3.0-4.6-3.0 for

JJ) (see Results Chapter, Table 4.1.5). The difference in the somatotypes of the Australian validation and main study samples was small and probably due to differences in sample sizes. While there are only a small number of studies of somatotype using Japanese subjects, Ohta and Ohta (2002) reported a somatotype of 2.8-4.1-3.1 from a study on Japanese children aged 6 to 17 years old. A difference in somatotype values could be due to a difference in age as the subjects of the current study had greater mean age than Ohta's sample.

No significant differences in anthropometric variables between the two Japanese groups (living in Australia and living in Japan). Hence both Japanese groups were combined in order to determine precise ethnic differences in body composition. The Australian Caucasian males had greater subcutaneous fat deposition in the lower body and higher girths and bone breadths. The current study confirmed the differences between Japanese and Caucasian males which was reported by a previous study using a smaller sample (Nakanishi & Nethery 1999). In the current study the predicted %BF values of Japanese groups were 16.4 ± 5.0 for the JA and 16.6 ± 5.1 for the JJ respectively and did not show a significant difference from the values obtained from their Australian Caucasian counterparts (17.3 ± 5.7). The obtained %BF values were higher than those values reported in previous cross-ethnic studies (Kitagawa 1978; Nakanishi & Nethery 1999). Possible reasons for the difference are the year the study was conducted (ie, secular trend), use of different methodologies, and differences in the age range of the study populations.

One of the most noteworthy findings in the current study was an ethnic difference in the BMI-%BF relationship. These results support previous findings (Wang et al. 1994; Deurenberg, Deurenberg-Yap & Guricci 2002; WHO 2004) that Asians have greater %BF than Caucasians at the same BMI values. This is the first time this difference in BMI-%BF relationship has been reported for young Japanese males.

Japanese males had an equivalent percentage of total body fat that Australian Caucasians had at their BMI of 25 (WHO Pre-obese) and 30 (WHO Obese class I) at 1.4 BMI units lower (values of 23.6 and 28.6) respectively. These values are lower than the WHO standard classification and are also below the Japanese-specific classification proposed by Japan Society for the Study of Obesity (JASSO) classifying 18.5≤ BMI <25 as “Normal”, 25≤ BMI <30 as “Obese class I” and 30≤ BMI <35 as “Obese class II” (Matsuzawa et al. 2000) (see Table 2.2 for details of classifications).

The previous JASSO cut-off point of 26.4 was reconsidered after the 1997 meeting held by the WHO that proposed BMI cut-off point of 25 as pre-obese, and 30 as obese. This reconsideration was to make the Japanese cut-off point to be in line with the global standard (Matsuzawa et al. 2000). However, only a small proportion of Japanese have the BMI values greater than 30. In addition, reported studies on increased hypertension and type II diabetes risks among individuals with BMI values above 25 lead to a proposal of new JASSO classification using BMI value of 25 as “obese” (Matsuzawa et al. 2000). However, the current JASSO classification was not proposed on the basis of the BMI-%BF relationship, even though %BF is probably the most important variable in the prediction of future health problems. In 2000, the WHO, the IASO, and the IOTF proposed BMI cut-off points that are specific for populations living in the Asia-Pacific region (WHO/IASO/IOTF 2000). In addition, recently the WHO proposed the cut-off points of 23 (low to moderate risk) and 27.5 (moderate to high risk), as the cut-off points for a public health action for all population (WHO 2004). However, it is uncertain that this will be reconciled with the specific recommendations made by the WHO for populations of the Asia-Pacific region.

To support these new cut-off points, recent studies conducted on Japanese populations concluded that Japanese males could develop health problems even within the BMI range of 20-24 (Hsieh et al. 2000; Ito et al. 2003; Anuurad et al. 2003). From the study on 3343 men (mean age 45.5 years), Hsieh, et al. (2000) reported that the group with the BMI range of 20-24 and with a waist-to-height ratio of above 0.5 has the odds ratios of developing hypertension, hyperglycaemia, hypertriglyceridaemia, low HDL cholesterol, hyperuricaemia and fatty liver of 1.42, 1.49, 1.95, 1.87, 2.00, and 2.57 respectively when compared with the group of the same BMI range but with a waist to height ratio of below 0.5.

Ito, et al. (2003) examined 2,728 Japanese (768 males, 1,960 females, mean age 44.6 for males, 45.1 for females respectively) for a cardiovascular risk factors and with assessments of body composition using DXA scan (Hologic® QDR-2000). From their study, they suggested that the cut-off point of the BMI for Japanese males for obesity should be 23.5kg/m^2. While these studies have a higher mean age group than the current study, these studies did consider the fat distribution pattern and body composition together with the risk of developing health problems.

Based on findings of this study, the BMI classification that most appropriately reflects body composition of Japanese males was found to be the classification proposed specifically for the Asia-Pacific population (ie, 23-25 as “Overweight (at risk)”, and 25-30 as “Obese class I”). The BMI cut-off points proposed for Japanese males from this study (23.6 for “Overweight”, 28.6 for “Obese” classifications respectively) appropriately positioned within the Asia-Pacific classification. These cut-off points are also above the newly proposed cut-off points for the public health action (ie, 23.0 and 27.5) by the WHO (WHO 2004). In order to apply BMI as an effective screening tool for Japanese adult males, it is recommended that the Asia-Pacific classification be used.

A potential problem from the application of a BMI classification that does not reflect a person’s body composition is the failure to predict the risk of developing health problems. Such failure may be more likely to occur to individuals who are described as “masked obese”. Although they have an excessive amount of body fat deposition, many of them are often misclassified as “healthy” because their BMI values are within the “normal” WHO BMI range. By selecting an appropriate BMI classification that reflects the body composition of the study group, it is possible to detect “masked obese” individuals more precisely. In the current study, the proportion of Japanese males who could be classified as “masked obese” was reduced from 66% when using the WHO classification to 35% when the new Asia-Pacific classification was used. This value is slightly higher than the result (30.4%) obtained from the study conducted in Japan using 1,278 men (mean age 18.7) (Fujise & Nagasaki 1999). The difference could be due to the sample size as well as the BMI cut-off point they used. Fujise and Nagasaki (1999) used a cut-off point of 24 according to a previous classification proposed by JASSO in 1993. While Fujise and Nagasaki (1999) conducted a study to compare gender differences, no study has examined differences across ethnicity. The current study showed the importance of using BMI cut-off points appropriately for the study population. When using the appropriate cut-off points (ie, WHO classification for Australians and Asia-Pacific classification for Japanese), there was no ethnic difference in the proportion of individuals who were classified as "masked obese" (see Results Chapter, Table 4.1.9).

Part II. Lifestyles

5.3 Differences in lifestyle and nutrition intakes between Japanese living in Japan, Japanese living in Australia, and Australian Caucasian males

Changes in lifestyle, including eating behaviours, have been observed in groups of people living in foreign countries (Pan et al. 1999) and in particular in those who have been living overseas for long periods of time (Kudo, Falciglia & Couch 2000; Freire et al. 2003). In the longer term, changes in diet will have an effect on body composition and health status (Wenkam & Wolff 1970; Huang et al. 1996). These studies have usually focused on the elderly, or on a comparison between generations, whose exposure levels to the migrating culture are different. In this study differences in lifestyles between groups of different ethnic origin have been examined along with the impact of living in different country on changes in their lifestyle variables.

5.3.1 Living conditions, eating habits, and physical activity

In this study, differences in living condition, physical activity levels and eating habit between study groups were assessed. The responses from the questionnaire showed that more than half of the JA subjects speak English at home. These subjects usually lived with host families or shared accommodation with friends of different ethnic backgrounds. This may suggest that the JA subjects are likely to be exposed to different cultural values.

Japanese males living in Australia reported a similar intensity of physical activity compared with those living in Japan. In addition, there was no significant differences in frequency of vigorous physical activity participated at leas once a week by Japanese males living in Japan (85.7%) and those living in Australia (72.1%). From the results there was no change in their attitudes towards physical activity, even though more opportunities for exercise are available in Australia. Apart from opportunity, the major factors that trigger individuals to exercise are enjoyment and the motivation to be fit and healthy. From the results obtained in this study it is possible that Japanese males may not possess the same motivation as their Australian counterparts. The amount of lean body mass, which includes a skeletal muscle mass, in relation to the stature of Japanese has been found to be smaller in Japanese men compared to Caucasians (Komiya & Nakao 2002). The results of this study suggest that the greater intensity and frequency of Australian Caucasian males' involvement in physical exercise may at least partly explain the differences in body composition between the two ethnic groups.

As with the physical activity responses, attitudes towards food held by the JA group did not differ from the Japanese sample living in Japan. Both Japanese groups reported that approximately 40% of them do not consume breakfast and about 30% of them do not eat three meals a day. The most recent report of the National Nutrition Survey of Japan showed that prevalence of individuals who do not eat three meals a day is highest among males aged between 20-29 years old (46.3%) (KEJK 2003). This indicates that the results from the present study are consistent with the National Nutrition Survey results and the specific eating behaviours described in Chapter Four, particularly of not eating three meals a day, is typical of Japanese males in this specific age group. A similarity in eating habit responses between Japanese groups could be due to a similarity in subject characteristics. Approximately 50% of the JA group were living with share mates. Although many of the JJ group live by themselves alone, both groups may need to prepare their own meals and thus their meal preparation skill may contribute to their regular meal consumption. In addition, as approximately 50% of the JA group had spent less than three months in Australia at the time of assessment, there had been little time for their eating habits to change. Consequently it is most likely that their responses reflect continuation of their same lifestyle and attitudes as they live in Japan.

Individuals who are willing to travel and to stay in foreign countries are assumed to have a different level of Westernised values than individuals who remained in Japan. The results of the SL-ASIA questionnaire indicated that the JA group held more "Western" values than the JJ group. Therefore it is likely that the JA group is a specific sub-group of Japanese males. This assumption is consistent with that made by Waller and Matoba (1999), when they used the term “selective migration”. If individuals originally have more Western values, they are more likely to travel and immigrate into Western societies. In this study, however, no strong associations between levels of Western values and their lifestyles or body image responses were found.

5.3.2 Ethnic and environmental influences on nutrient intakes observed in Japanese males living in Japan and Japanese and Australian Caucasian males living in Australia

This study also aimed to determine the nutrient intakes of Japanese young adult males living in Australia and to assess differences in comparison with those living in Japan and to Australian Caucasian males living in Australia. There have only been a limited number of studies of Japanese males that have assessed diets and dietary patterns and compared the results with other ethnic groups. This study may be the first cross-ethnic, cross-cultural study using Japanese males, and particularly younger Japanese males living in a foreign country.

In order to determine the balance between energy intake and energy expenditure, and hence to assess the accuracy of the dietary record, the EI/BMR ratio was calculated for each study group. The EI/BMR ratio can be used to assess an adequacy of energy consumption to maintain a normal lifestyle. A low EI/BMR ratio value may indicate unusually low energy consumption that is a consequence of dieting or inadequate access to food, and also a possibility of under-reporting of food intake by the subjects (McLennan & Podger 1998). After removal of potential over- and under-reporters, differences in the EI/BMR ratios between the study groups were examined. The study found no significant difference between the JA and the JJ groups but showed that the JA has the lowest ratio among three groups. This could be a consequence of possible under-reporting by these subjects. However, considering the significant difference in total energy intake between the JA group and the Japanese National Nutritional Survey (JNNS) results, the result may indicate a decline in the total energy intake among Japanese males living in Australia. This could be due to a combination of 1) missing a breakfast and 2) low exercise levels and 3) poor meal preparation skills which Japanese males have, in addition to 4) financial reason of the JA subjects in comparison with the JJ counterparts.

The mean energy intake of the JA group was significantly lower than the JNNS result of the similar age group (see Results Chapter, Figure 4.2.1). For those living in their home countries, the JJ group showed no difference in total energy intake compared to the JNNS result (see Results Chapter, Figure 4.2.1) (KEJK 2003) but the AA group showed significantly lower energy intake compared to the ANNS result (see Results Chapter, Figure 4.2.2) (McLennan & Podger 1998). The result obtained from the AA group may be because of their lower fat intakes that resulted in lower energy contribution from fat compared to the ANNS result. In this study, Australian Caucasian males consumed a greater amount of energy than Japanese males in relation to their BMR. As reported in the study (Table 4.2.3), Australian males were involved with exercise more frequently than Japanese males. The greater energy consumption among Australian Caucasian males may be a result of their effort to balance out their "expected" energy expenditure. In addition, because their frequent engagement with physical activity may indicate their strong interest on health and fitness, they also reported more awareness about the food they consumed compared with Japanese males.

Using the JJ and the AA results as references, the nutrient intakes of the JA group were assessed. Significant differences in nutrient intakes between ethnic groups may be explained by differences in body size and their energy requirements related to their BMR and exercise level. However, significant differences in energy contributions from major nutrients, such as protein, carbohydrate, and fat across study groups may indicate differences in the foods they consumed. In comparison with the Japanese living in Japan, the Japanese living in Australia showed greater proportions of energy from protein and fat and a lower proportion of energy from carbohydrate. The energy contributions from protein (16.3 ± 3.1%), carbohydrate (47.3 ± 6.7%), and fat (32.3 ± 5.7%) of the JA group were similar to that of Australian Caucasian males (protein: 17.1 ± 3.7%; carbohydrate: 47.9 ± 6.0%; fat: 30.6 ± 5.7%). This difference in energy contribution of the JA group from the energy contribution of the JJ group (protein: 14.4 ± 2.0%; carbohydrate: 50.4 ± 6.1%; fat: 28.1 ± 5.0%) also indicates a change in food consumption. In support of this possibility, Japanese males living in Australia showed similar consumption of fat to Australians. Both groups living in Australia consumed more energy from saturated and monounsaturated fat but less from polyunsaturated fat than the amount the JJ consumed (Table 4.2.4). Several possibilities may have contributed to the differences between the JA and the JJ results. Low carbohydrate consumption may be associated with unhealthy eating behaviours, including not having a breakfast. In addition, frequent consumption of meat products, as well as high fat products that are readily available in Australia, might increase the proportion of energy contribution from protein and fat.

The current study documented nutrient intakes that are apparently the result of both ethnic and environmental influences. Most of the nutrient intakes of the JA group lay in the middle of intakes by the JJ and AA groups. Among the nutrients assessed, the JA group consumed a significantly higher amount of calcium, iron, dietary fibre, and niacin equivalent than the JJ group. Calcium and dietary fibre are two of the major nutrients that Japanese consume less than the Recommended Dietary Allowance (RDA) of Japan (700mg calcium and 20-25g dietary fibre intakes for Japanese male aged 18-29 years old) (KEJK 1999). Although they did not consume 100% of all of the Japanese RDA values, the JA group achieved better intakes than the JJ group. The increase in calcium and dietary fibre could be due to increased intakes of dairy products as well as cereals, fruits and vegetables, which also indicate a further Westernisation of their diet by the JA group. A change in nutrient intakes can be expected as about 50% of JA subjects were living as “home stay”, which made them consume the same diet as their host families. In addition, reduced availability and accessibility of Japanese products due to cost may also be responsible for their change in diet thus in their nutrient intakes.

From the study, the Japanese living in Australia had a similar macronutrient energy distribution to Australian Caucasian males rather than to those Japanese living in Japan. This finding was similar to a previous study that suggested a Westernisation of dietary habits among overseas students, predominantly from China and Taiwan, in the US (Pan et al. 1999). Acknowledging that diet in Japan has become more westernised in recent years, the results obtained in this study show that further westernisation is still possible in the diet of Japanese males living in Australia.

Although their dietary patterns may have been improved by the increased intakes of some nutrients, such as calcium and dietary fibre, the increased energy contribution from fat could be a concern for the development of health problems in the long-term if they remain in Australia or their dietary change becomes permanent. In addition, because of their low total energy consumption and physical activity level, it is unlikely that the JA subjects to experience a dramatic change in their body mass.

The current study found that while Japanese males living overseas have changed their nutrient intakes, their basic attitudes towards food had not changed. The study also showed that attitudes towards eating and physical activities that were similar to those possessed by the JJ group, which may indicate retention of the general attitudes towards lifestyle possessed by Japanese males. Because of low energy intake as well as low physical activity level, the JA group is unlikely to experience serious health problems during their short stay in Australia. However, the influence of the eating experience in Australia to their future eating habits and consequently to their health condition in a case of long-term stay in Australia as well as after their return to Japan remains uncertain. While there were some evidence of increased intake of nutrients among the JA group, it may also be beneficial for them to maintain their energy contribution pattern from major nutrients (ie, protein, carbohydrate, and fat) to the same level of the JJ group. Although maintenance of own health is largely depending on individuals' attitude on health and their ability to manage healthy lifestyle, any support that increases their awareness on their own health may be beneficial to live in a foreign country of a different cultural background.

Part III. Body image

5.4 Validity of the Somatomorphic Matrix computer program

Since its development, the Somatomorphic Matrix (SM) computer program has been used as a tool to assess body image with consideration of measured body composition of subjects (Gruber, Pope Jr. & Borowiecki III 1998; Pope Jr et al. 2000; Gruber et al. 2001). The program used anthropometry as the standard for its development. However, there has been no further validation using advanced body composition assessment methods such as DXA or CT scanning and thus there is some doubt weather the body composition values allocated to each image of the program are valid. It is now impossible to re-measure the same subjects who were involved in the development of the program using advanced methods. The program may be considered valid if subjects select the perceived "own" image from the SM program which has %BF and muscularity values the same as the actual body composition values of the subjects. The previous study of the validity of the SM program only used population mean values (Gruber, Pope Jr. & Borowiecki III 1998) and there are no reported studies assessing inter-variability of body compositions of subjects and values allocated to their selected image. Also there are no reported studies compared body composition values of the SM program and subjects using detailed body composition assessment methods, such as DXA.

The Fat Free Mass Index, (FFMI) is an index that the program used as an indicator of muscularity. It was first proposed by VanItallie, et al. (1990) as a useful tool in nutritional assessment based on a study using a reference population of 124 healthy young men and 32 non obese young men. The SM program used the equation proposed by Kouri, et al. (1995) that was based on anthropometry from a sample of 157 athletes. As there had been no previous study on the appropriateness of their FFMI equation for non-Caucasian subjects and also because the equation was developed from a specific sample population (ie, athletes), in the present study the association between FFMI and body composition variables (using DXA scan data) of the study groups was examined. The results showed that FFMI correlated with lean body mass and body mass, but the FFMI is not correlated with FM and %BF in this sample. This indicates that the FFMI may represent FFM of subjects and hence could be used as an indicator of muscularity for both ethnic groups. Both corrected arm and calf girths also correlated well with lean body mass of the regions (ie, right arm and right leg) that were obtained from the DXA and also with FFMI. While a corrected arm girth correlated with both lean and fat masses in Japanese males, it can be suggested that both corrected girths and FFMI can be used as an indicator of muscularity (see Results Chapter, Table 4.3.2).

The current study found a discrepancy between measured and perceived “own” %BF of approximately 10 percentage points (see Results Chapter, Figure 4.3.1). Similarly, there was a discrepancy between measured and perceived “own” muscularity represented by FFMI of about 3kg/m^2 (see Results Chapter, Figure 4.3.2). There were no ethnic differences in observed discrepancies. The results show that the body composition values obtained from the perceived physique using the SM program do not reflect the subjects’ measured body composition. According to Gruber, et al., (1998), an FFMI of 20 indicates average muscularity for young males, whereas an FFMI of 18 would be a person with slight build and with low muscularity and an FFMI of 22 would be very muscular person. The findings of this study suggest that both %BF and FFMI values selected by the subjects as “own” physique using the SM program do not reflect the actual body composition of the subjects. Further, a wide variability between perceived and measured body composition values suggests that it is inappropriate to use the SM program as a substitute for actually measuring body composition.

While the SM program can be used to ask subjects a range of body image-related questions to obtain their “ideal”, “goal”, and “preferred” images, the current findings suggest that the results from these questions may not necessary reflect what they would like to have in reality. These results also suggest a risk to compare the results from the SM program with the measured body composition values using detailed body composition assessment methods (eg, DXA and anthropometry). However, the SM program may be used as a standard instrument to compare the results obtained from different study groups, such as different ethnic groups, to observe differences in their body image. Therefore, the applicability of the program in current format may be restricted to a determination of body image trend of study groups. This finding also suggests an importance of determining individual variability in their selection of "current" image. The previous studies (Gruber, Pope Jr. & Borowiecki III 1998; Pope Jr et al. 2000) reported and compared a mean values of measured body composition and the SM results. Using mean values rather than individual measurements often masks the presence of differences obtained from individual results.

Possible causes of wide variability of the measured body composition values and the values obtained from the "own" physique of the SM program are: 1) the inappropriate allocation of body composition values with the prepared images (ie, errors in the program design), 2) the misperception of "own" physique by subjects, and 3) the combination of two factors. As there is no significant ethnic difference in variability of the measured and selected body composition values, there may be no interference of the visual representation of images that were drawn for use in the SM program. Rather, a selection of population-specific prediction equations to determine body compositions of original samples and its allocation to each image may have interfered with the error. In addition, there is a suggestion that overestimation of muscularity could be due to an "optimistic view" of one's own muscularity (Pope, Jr., 2002 personal communication). As the current study was unable to determine the factor that caused the error, a future study is recommended in order to improve the program and broaden the opportunity to link the psychological and physiological aspects of body image.

To allow assessment of body image in relation to body composition values, it would be ideal to demonstrate high agreement and low variability between the measured body composition values of subjects and the values that were selected as "own" physique using the SM program. As there was poor agreement and high variability between measured values observed in this study, further development and modification of the program is recommended. Improvement can be achieved in several ways. The application of advanced body composition assessment methods, such as DXA and NMR, and an inclusion of functions that enables change in body composition values and corresponding images according to characteristics of study subjects such as by ethnicity may increase validity and applicability of the program to wider study population. In addition, the current program has an underlying assumption that body perception is made from a front view of a physique. However, as the human body is three dimensional and there is no evidence that body perception of every individual are determined by a front view of physique. In order to overcome this concern as well as to minimise bias and confusion that could evolve by the way image was drawn and depicted by subjects, a development of the program using the digital three dimensional images with anatomical position is recommended.

The current study has a few limitations that need to be considered. The Japanese involved in the study lived in Australia and therefore their body image may be different from those living in Japan. Hence, confirmation of the current study using a larger sample size as well as inclusion of those living in Japan in study groups is required in future study. In addition, although it has been suggested as minimum effect on the predicted values (Gruber, 2001 Personal communication) and its validity against the DXA scan, a "gold standard", was shown, use of different methodology with regards to anthropometry might have been affected in a statistical analysis.

5.5 Validities of the BAQ and the ABS questionnaires

In addition to the SM program, this research involved the validation of two English language questionnaires; the Ben-Tovim Walker Body Attitudes Questionnaires (BAQ) and the Attention to Body Shape Scale (ABS). These questionnaires were developed by researchers in Australia and the USA (Ben-Tovim & Walker 1991; Beebe 1995). However, these questionnaires have only been assessed for use with females and have not been used to assess the body attitudes of males. As there is a lack of questionnaires to assess the body attitudes of men and, including the use of Japanese-translated version, the use of these questionnaires was examined in this study.

In the previous study, the BAQ showed an internal consistency of 0.87 using 504 females (Ben-Tovim and Walker, 1991). The current study using males gave alpha levels ranging from 0.86 to 0.87 (see Results Chapter, Table 4.3.3), which were equivalent to the original study reported by Ben-Tovim and Walker. Similarly, the alpha levels of the ABS for 22 males ranged from 0.70 to 0.82 (Beebe 1995). In this study, the alpha levels ranged from 0.78 to 0.80 (see Results Chapter, Table 4.3.3). These results suggest that both BAQ and ABS questionnaires have high levels of internal consistency for Japanese and Australian Caucasian males.

The current study also assessed test-retest repeatability after 12-months of the baseline assessment (see Results Chapter, Table 4.3.7). The Japanese groups (ie, JA and JJ) showed a satisfactory level of repeatability in both BAQ and ABS questionnaires. Australian males also showed a good repeatability in the ABS scores but the BAQ score at 12-months assessment differed from the baseline score.

Inter-correlations between the BAQ subscales were assessed to determine if the correlations were equivalent to the previous study using Australian females (Ben-Tovim & Walker 1991). The results obtained from Australian males in this study (see Results Chapter, Table 4.3.4) were very similar to those obtained from Australian females in the original Ben-Tovim study. Inter-correlation results between Australian Caucasian male and Japanese counterparts were also comparable. Both Japanese groups however showed lower correlations between lower body fat subscale and strength subscale. No correlation between these two subscales was observed in the Australian group. In addition to high internal consistency, equivalent levels of inter-correlations between subscales may support applicability of the BAQ to both Japanese and Australian Caucasian males.

The EAT is widely accepted as a screening tool to assess the risk of developing an eating disorder. This study showed correlations ranging between 0.46 and 0.58 for the BAQ and the EAT total scores among each of the study groups (see Results Chapter, Table 4.3.5). In addition, the EAT total score was correlated with the ABS score within the range of 0.45 to 0.46 among the study groups. When the correlations between the questionnaires and the EAT subscales were assessed, the BAQ strongly correlated with the dieting subscale ranged 0.61 to 0.75, and lesser extent by the ABS (ranged 0.46 to 0.58). The findings from the current study suggest that both the BAQ and the ABS are sufficiently valid and reliable to be applied to both Japanese and Australian Caucasian males. Nonetheless, in order to confirm the current finding, a replication of the study to a larger study group is recommended. In addition, as Japanese-translated questionnaire appears appropriate, the questionnaires can be administered to Japanese females to examine its validity and reliability for this particular group.

This study found ethnic differences in scores obtained from the BAQ and the EAT subscales. The results showed that Japanese males possessed negative thoughts toward themselves, whereas Australian males were confident about themselves, in particular with their strength and attractiveness. The poor self-confidence possessed by Japanese is similar to the findings by Lerner, et al. (1980). The current study did not find a difference in self-esteem between Japanese males living in Japan and those living in Australia. This finding was different from the finding by Waller and Matoba (1999) using Japanese female subjects in the UK (aged between 18 and 30 years). In their study, Japanese women living in Japan showed a lower level of self-esteem than the other two groups living in the UK and also found a similar relationship between eating behaviour and psychological functioning of Japanese women living in the UK to that of the British women (Waller & Matoba 1999). This may be associated with differences in gender of subjects and the duration of which subjects stayed in foreign country.

No other published reports have been found reporting on differences in body attitudes possessed by Japanese males in comparison with Australian Caucasian males. This study suggests lower self-confidence possessed by Japanese males than Australian Caucasian males and together with previous findings, Japanese are likely to possess lower self-confidence than Caucasian counterparts. As self-confidence can be expected to influence on their one's own body image, it is possible that Japanese subjects over concern unnecessarily. Hence, these differences in body attitudes may be key issues when interpreting ethnic differences in body perception in relation to their assessed body composition.

Australian Caucasian males showed significantly greater EAT total scores than both the Japanese groups and also showed greater dieting subscale scores than Japanese males living in Japan (see Results Chapter, Table 4.3.6). This can be interpreted as Australian Caucasian males are more likely to develop unhealthy weight-control behaviours than Japanese males. However, the EAT scores of Australian Caucasian males were not associated with their anthropometric variables or their differences between “measured” BMI and their perceived “ideal” BMI values (see Results Chapter, Table 4.3.17). This indicate that their EAT scores may not be due to their excessive concern toward their weight or body fatness. Rather, considering their strong awareness of food intake compared with their Japanese counterparts, the high scores may be a reflection of their daily eating behaviour and not an indication of abnormal dieting behaviours that may lead to eating disorders.

5.6 Ethnic differences in body image on males

The current study aimed to examine various aspects of body image of Japanese and Australian males to assess the possible associations of body image issues, such as distorted body perceptions and body dissatisfaction, with the risk of becoming obese and unnecessary dieting behaviours. There are limited numbers of reported studies that focused on males’ body image using detailed body composition assessment methods. In addition, no study has been reported body image of Japanese males in comparison with males of other ethnic backgrounds. Therefore, this study is to fill the gap of knowledge that links the areas of public health and kinanthropometry, as well as psychology where the topic of body image has been assessed frequently.

The body image assessment included aspects of; body perception, body satisfaction and body acceptability. General body images possessed by males of each ethnic background were assessed using questionnaires and the SM program. Also their perceived body image and body satisfaction were examined in relation to their measured body composition that was obtained from anthropometry. In addition the potential risk of developing disordered eating behaviours was examined using the EAT-26 questionnaire as the criterion.

5.6.1 General body image and body concerns possessed by Japanese and Australian Caucasian males

This study has found that males of both ethnic backgrounds perceived the ideal physique as having greater muscularity and lesser amounts of body fatness than their perceived current own physique. This result of wishing for a more muscular body is similar to the findings of previous studies (Silberstein et al. 1988; Paxton et al. 1991).

From a study assessing body dissatisfaction of 45 female and 47 male undergraduate students using the Body Size Drawing questionnaire, Silberstein et al. (1988) reported that men were as likely to express a desire to be heavier (43.4%) as to be thinner (34.8%) compared with females, who almost always wished to be thinner. Similarly, Paxton et al. (1991) reported that 30.1% of 221 male high school students selected an ideal figure that is bigger than their perceived current image using the Body Perception Questionnaire. These questionnaires administered in previous studies are equivalent to the Figure Rating Scale and therefore, as suggested by Cohane and Pope Jr. (2001) these studies failed to clarify if they wish to be muscular physique or simply wish to become "bigger" in size. The current study has confirmed that males wished to become muscular. The study also found that individuals who perceived themselves as having large amount of muscle tend to select a less masculine physique as "ideal". Similarly, individuals who perceived themselves as having a small amount of body fat selected an image with greater amount of body fat as their ideal. Those who perceived themselves as having a large amount of body fat selected an image with small amount of body fat as their ideal. These results may indicate a greater body dissatisfaction among individuals not only those perceived themselves as having a large amount of fat or small amount of muscle, but also among those who perceived themselves as too thin or too muscular. The results of this study show that the perception of this ideal image is consistent among males of different ethnic backgrounds, within the limits of the sample size used.

The current study also examined any differences in body acceptability, a range of physiques that the subjects considered not "too thin" or "too fat", using the SM program. All study groups showed comparable range of physiques of %BF and muscularity (as represented by FFMI) to be acceptable (see Results Chapter, Table 4.3.10). The above findings, however, may not represent the true body composition values the individual subjects wished to have and it also may not present precise differences in acceptable physiques. This is due to a wide variability between the measured body composition and perceived "current" physique using the SM program observed (Figure 4.3.1 and 4.3.2). To detect any smaller differences in physique acceptability between ethnic groups and any interaction with their living environments, the development and application of a more advanced body image assessing tool is recommended for use in future studies.

With regards to body concern possessed by Japanese and Australian Caucasian males, the study found potential ethnic differences and environmental influence. Australian males compared themselves with those in the media more than the Japanese groups. In addition, a larger proportion of Australian males reported previous attempts to gain weight and their use of protein and creatinine supplements was more frequent than their Japanese counterparts. Considering significantly frequent physical activity and strong awareness of their own food intakes (see Results Chapter, Table 4.2.2 and 4.2.3), Australian males may be more preoccupied with muscularity than the Japanese males. However, both Japanese and Australian Caucasian males selected an ideal male physique of similar %BF and muscularity values using the SM program. Ethnic differences in awareness of food intakes and involvement in physical activity could be due to differences in perceived ideal masculine physiques between Japanese and Australian males.

A previous study has found that Japanese females prefer males with a "unisexual physique" (Takeda, Suzuki & Muramatsu 1996). If the transition of Japanese male's standpoint from "selecting" partner to "being selected" by a partner suggested by Ishihara (2000) is true, then Japanese males would not like to have a physique with a visually recognizable large muscle mass. Even if the statement were not true it is also possible that Japanese males themselves possess an ideal male image of a unisexual physique, and this could be due to an influence of the media. By comparison, the physiques represented by Australian-rule football players are stereotypical "the ideal male physique" for Australian males. In other words, the body image of the Japanese male may be highly influenced by their perceived females' preferred ideal male physique. This image, however, may not be the true image which females actually prefer. There are Western studies that suggest a difference between the image that opposite gender truly prefers and the "perceived" ideal physique preferred by the opposite gender (Fallon & Rozin 1985; Cohn et al. 1987; Rozin & Fallon 1988; Furnham, Hester & Weir 1990). These previously reported studies, however, did not examine the preferred physique with reference to the actual body composition values. Also because of a lack of Japanese studies of similar design, it is important to confirm the findings of the current study.

While the AA group compared themselves with those in the media, the JA group more often made a comparison of their own physiques with other males they saw on the street. This may be an indication of the rising level of body concern in the Japanese living in Australia, as a consequence of increased exposure to a variety of physiques by changing their living environment. As a result of increased opportunities for comparison of own physiques with the others living in the society, the JA may alter their body image in relation to their actual physique or composition. Body composition is an important indicator of a number of health problems. Therefore change in body image in relation to the body composition may either increase or decrease a person's risk to develop health problems.

5.6.2 Body image in comparison with the subjects' body composition as measured by anthropometry

Unlike many previous studies, one advantage of the methods used in the current study was the use of detailed body composition assessments. This enabled any ethnic and environmental influences on the subjects' body perceptions to be studied in relation to their anthropometric variables. In comparison with their measured body mass, all groups showed a wide variability (ranged 8 to 12kg) in estimating their own body mass. Furthermore, the study showed a greater desire of weight gain among individuals with small body mass. This result supports O'Dea (1995) who stated that males who wished weight gain are most likely to be groups who are underweight or perceived themselves as underweight.

This study also examined ethnic differences in agreement between their perceived "fatness" (ie, their perceived amount of total body fat deposition) and "heaviness" (ie, their perceived heaviness of the body mass) to anthropometric variables obtained from the measurement. Using the BMI as an indicator of "heaviness" and %BF and sum of skinfolds as indicators of "fatness", the weighted Kappa results showed agreements that ranged from 0.42 to 0.55 were obtained for their perceived "heaviness" whereas lower levels (0.28-0.35) were obtained in the agreement between their perceived "fatness" and measured %BF (see Results Chapter, Figure 4.3.7). An agreement between the perceived "fatness" and sum of skinfolds showed that the JJ subjects possess a better understanding of their body fatness than the AA and the JA counterparts. Considering non significant differences in body composition variables, such as %BF and the sum of skinfolds, the differences in the agreement values indicate a greater distortion in body perception among the JA group in comparison with the JJ group.

Details of perceived "fatness" and "heaviness" of Japanese and Australian Caucasian males in relation to their measured values (ie, BMI, %BF, and sum of skinfolds) showed ethnic differences (see Results Chapter, Figure 4.3.8 and 4.3.9). Australian Caucasian males used in the current study tended to be more optimistic and many underestimated their actual levels of heaviness and fatness. Many previous studies have found that males underestimate their fatness and hence they are at risk of becoming overweight (Valtolina 1998; Blokstra, Burns & Seidell 1999; Donath 2000). Therefore the current study confirmed the presence of the same trend, which has been reported in previous studies, among Australian Caucasian males. However, this study showed that such a trend does not exist in both of the Japanese male samples. Both of the Japanese groups were pessimistic about their own bodies and overestimated their body composition, particular the degree of body fatness. Rather, as Rand and Kuldau (1990) suggested, this study supports the view that body perception varies depending on ethnic and cultural variables.

In the current study, the pessimistic perception of Japanese males can also be expected from a high self-disparagement subscale score obtained from the BAQ, while their Australian counterparts had low mean scores on the same scale. As both JA and JJ groups showed pessimistic body perceptions and also similar self-disparagement scores, it could be suggested that, overestimation of their own physiques is likely to be an ethnic characteristic of Japanese male. The current study also showed a difference in body perception between the JA and the JJ groups. The JA group showed a greater overestimation of own body fatness then the JJ group. The results may indicate an alteration of body perception among the JA subjects since their stay in Australia. By living in a society where various ethnic groups of different physiques can be observed, the JA subjects may have experienced a decline in their ability to perceive themselves correctly.

The presence of associations between body satisfaction and anthropometric variables in females has been reported in previous studies (Davis et al. 1994; Page & Fox 1998). The current study, however, showed only low levels of association between body satisfaction and anthropometric variables for Australian Caucasian males and Japanese males living in Australia and no correlation at all was found for Japanese males living in Japan. In addition, no strong correlations between anthropometric variables and the BAQ self-disparaging and attractiveness subscales were observed regardless of study groups. These results may indicate that the body satisfaction levels of males are not necessarily associated with their actual physiques.

These findings suggest that the levels of body satisfaction of males may be strongly influenced by environmental variables, such as peer pressure, comments from family or from the opposite gender. In addition, even though correlations were low, the similarity between the JA and the AA groups may indicate a modification of anthropometric information of the JA as a variable for body image-decision making, such as body satisfaction and indicator to commence dieting behaviours. The current study showed that the JA group frequently compared their physique with the others in the media or on the street compared with the other groups. This may be an indication of increased awareness toward their own physique, as they are exposed to different physiques by changing their living environment. Unlike in Japan, which is a more homogenous society, a presence of wider range of physiques in Australia may lead the JA group to alter their body image during their time spending in Australia. As a result of the alteration of their body image, body satisfaction toward their own physique may have altered.

5.7 Risks of developing health problems

Body perceptions were assessed in relation to the subjects' perceived "heaviness" and "fatness", using the BMI as an indicator of "heaviness" and %BF and sum of skinfolds as indicators of "fatness". While both Japanese and Australian Caucasian males did not show a precise body perception in relation to their actual body composition, better understanding on their actual "heaviness" than the actual body "fatness" was observed from the results (see Results Chapter, Figure 4.3.7). There were no differences in ethnicity.

The BMI is a simple index that frequently been used to assess a level of obesity (and hence to assess health risks) in large epidemiological studies. However, it is only a ratio between body mass and stature and is strongly affected by the proportion between the ratio of trunk and leg lengths (Garn, Leonard & Hawthorne 1986; Ross et al. 1988). Therefore it has been recommended to be used only as an indication of heaviness and is not considered appropriate to determine the body composition of individuals by itself. Using the BMI classifications that most closely correlate with the %BF of each study group (see Discussion Chapter 5.2), the results showed slightly better agreement in their perception towards their heaviness than their perception towards their level of fatness. As the actual body composition (ie, %BF) is a more important variable in predicting health risks than the BMI and also body mass that subjects may have used to judge their level of fatness, poor understanding of body composition may lead to a misperception of the subjects own health status.

These misperceptions could affect human health in the following ways;

1) An excessive concern about the subject's own level of fatness could lead to unnecessary dieting practices, or
2) A lack of awareness of the subject's level of fatness would not provide any motivation to lose weight.

The current study showed that the Japanese groups have pessimistic thoughts about their own body, whereas Australian Caucasian males tend to have opposite views, ie, they have a more optimistic view about their bodies. Resulting from this, Japanese males may be at greater risk of developing disordered eating behaviours while Australian Caucasian males may be at greater risk of becoming overweight or obese.

In support of this assumption, the JJ group showed correlations between their EAT score and anthropometrical variables and also showed moderately strong correlations between the dieting subscale and variables such as the BMI, %BF, and sum of skinfolds. By contrast, the groups living in Australia (ie, JA and AA) did not show any correlations between the EAT score and anthropometric variables. Correlations between anthropometric variables and the EAT subscales showed that the dieting subscale score and the difference between current and ideal BMI (ie, BMI-BMI$_{ideal}$) correlated strongly for all study groups. As the body mass is a component of the BMI, the results may indicate that a discrepancy between current and ideal body mass is an important variable for males to undertake dieting behaviours. From the regression analysis, while the JA and the AA groups did not show any anthropometric variables can be major contributing factors to conduct dieting behaviours as much as the BMI-BMI$_{ideal}$, the JJ group showed that their body mass is also a strong contributor for their dieting behaviours.

In contrast to Japanese males, Australian Caucasian males generally had a more optimistic body perception with 34.6% of individuals who had a BMI above 25 and 57.7% of those with a %BF above 20%, perceived themselves as not heavy or not fat. Although Australian Caucasian males showed a strong awareness of the nutritional value of food they eat and are involved with physical activities more frequently than Japanese groups, such misunderstanding of the actual body composition may lead to excessive energy intake. It is also possible for Australian Caucasian males to overestimate their actual energy output required for being physically active, which may lead to excessive energy intake. As a result, the AA group may be at high risk of becoming overweight or obese among the study groups.

An interesting finding was that more than 20% of Australian Caucasian males who were involved in the study responded that they were trying to gain weight and were using protein and/or creatinine supplements. Their behaviours reflected their strong desire to gain muscle mass. However because of their lack of understanding about their current body composition, many of them might not be sure if any weight gain was due to an increase of muscle mass or fat mass. In addition, while they consume an excess amount of protein or creatinine from supplements, if their physical activity level did not increase to meet their additional energy intake this extra protein will be stored as fat, and perhaps eventually lead to overweight or obesity.

Australian Caucasian males reported a greater awareness of the types of food they consumed and their involvement in physical activity than Japanese counterparts. However, their strong desire to gain muscle mass could also increase the risk of other health problem, known as a muscle dysmorphia. As described by Pope Jr., et al. (1997), muscle dysmorphia is a condition where the individual has a high level of preoccupation with the appearance and muscularity of their own body. While both ethnic groups wished to be muscular, Japanese males did not report taking much action to change their body structure. This may be due to a difference in desired ideal male physique or simply due to their lack of motivation to be involved in exercise. Nonetheless, the study results indicate a distinct ethnic difference in the risk of muscle dysmorphia and Australian Caucasian males are more at risk compared with Japanese males.

In some areas the JA group showed similarities to the AA group and in the other areas, their results were comparable to those obtained from the JA group, which construct a unique characteristic of this particular group. The study showed a greater pessimistic and distorted body perception among the JA group than the JJ group. In addition the JA subjects also increased the frequency of comparing themselves with the physique of others does as the AA group. From the results, it can be assumed that their increased body concern and pessimistic body perception may be associated with a risk of unnecessary dieting behaviours. However, there is a distinct difference in the correlations between the EAT total score and their anthropometric variables in comparison with the JJ group. While the JJ showed that the body mass was an important variable for their EAT dieting subscale score, the JA group did not show the same result. This indicates that, although they have similar physique including body mass and body composition with a greater distorted body perception than the JJ group, they may not commence unhealthy dieting practices.

From the obtained results, it can be stated that the JA group has a low risk of developing disordered eating than the JJ group even though they have distorted body perception. This could be explained by the effect of both ethnic and cultural influences. Because of pessimistic and self-disparaging characteristics, Japanese males tend to perceive themselves as having a large amount of body fat than they actually have. However, during their stay in Australia, where frequent exposure to a wide range of physiques is possible, the JA group may become more at ease toward their own physique compared to the JJ subjects who are living in a highly single-ethnic dominant society where people generally have slim physiques. Such change in living environment may lead to a reduction of preoccupation toward body mass and other anthropometric variables which they previously held while in Japan and lead to a reduction of unnecessary dieting behaviours among the JA subjects. In addition, while they wished to lose weight or to develop a muscular physique, their poor awareness of eating behaviours and minimum involvement in exercise makes it difficult to achieve their goal. Their low motivation also reduces their risk of developing muscle dysmorphia.

The current study showed that the JA group had a lower EI/BMR ratio than the other groups, which indicates a lower energy intake in relation to their energy demand. JA subjects may not experience a significant weight gain if they stay in Australia for a short period of time. As a result, the JA group can be considered as the group with the lowest risk of developing health problems among the study groups. The JA group however, consumed a diet that is generally high in fat and protein and low in carbohydrate. While this diet is unlikely to cause serious health problems among short-stay subjects, this diet is more energy dense diet than the traditional Japanese diet. Thus the JA subjects who stay in Australia for a longer period may have an increased risk of weight gain during their stay in Australia.

Because of their increased exposure to a variety of physiques in Australia, the JA individuals may learn to accept their weight gain without excessive concern during their stay in Australia. However, any unnecessary weight gain by the JA group may increase their concerns about weight loss just before or soon after their return to Japan. This is because Japanese males of the equivalent age group living in Japan generally have thin appearance and once they returned to Japan, they are likely to realise the amount of weight gained during their stay in Australia. Such increased preoccupation to lose weight may be reinforced by their pessimistic body perception and may accelerate their body image distortion. As a result, the JA group may have an increased risk of developing unhealthy eating practices after their return to Japan. Because there have been no previous studies on this subject, this must remain a matter of conjecture. Acknowledging a pessimistic body perception is a general ethnic characteristic of Japanese subjects, it is recommended for the JA group to avoid unnecessary weight gain during their stay in Australia by both diet and physical activity, to avoid this potential problem. As a part of this prevention strategy, to the JA group is advised to maintain an energy contribution pattern that is similar to the JJ group and to increase their awareness on diet as well as their involvement in physical activities.

This research examined ethnic and cultural impacts in a risk of developing health problems among Japanese and Australian Caucasian males. With consideration of body image in relation to body composition and potentially influencing lifestyle variables (food intakes and physical activity levels), it can be suggested that Japanese males living in Japan are more likely to involve with unnecessary weight-loss behaviours, whereas Australian Caucasian males may be more at a risk of becoming overweight or obese. Japanese males living in Australia showed different relationship between body composition and body satisfaction, body perception, and also dieing behaviours compared with Japanese males living in Japan. This difference may be associated with an influence of living in the society where allow them to become tolerant to a variety of physiques. However, as their pessimistic perception still remains, there is a possible risk of commencing dieting behaviours by the JA subjects if they experience weight change during their stay in Australia.

Chapter 6 - Conclusion

Research studies that have combined detailed body composition assessments using advanced methods and lifestyle variables, with assessments of body image are very limited, particularly in cross-ethnic or cross-cultural settings. This study of younger adult males (aged between 18 and 40years) compared Japanese living in Japan (JJ) and Japanese living in Australia (JA), with Caucasian Australians living in Australia (AA). A search of the available literatures suggests that this is the first study to report differences in body image, together with detailed body composition and assessment of lifestyle variables of Japanese and Caucasian males. There have been few reported studies on body image perception by males and the findings of this study may assist in re-evaluating the instruments that have been used in these studies.

6.1 Research findings

This study of younger Japanese and Australian males included three major areas:

1) Body composition,
2) Lifestyle, and
3) Body image

Several hypotheses were proposed and then tested for each of these areas.

Body composition

1) ***H_O: There is no difference in body composition, such as %BF, and its relationship with the BMI across males of different ethnic backgrounds.***

Australian Caucasian males were taller and heavier, and had greater BMI values and muscle mass than the Japanese males in this study. The study also showed that Australian males have significantly greater subcutaneous fat on their trunk and lower body than Japanese males. There were ethnic differences in the relationships between BMI and %BF were found with Japanese males having a greater %BF than Australian Caucasian males at any given BMI value. The results indicated that application of inappropriate BMI classification, originally developed for western populations, might have resulted in the misclassification of obesity in Japan. This has been described in the literature as the problem of “masked obese” among Japanese. Based on the findings of this study, lower levels of BMI for the classification of obesity in Japanese males are recommended. In the Japanese subjects the BMI values of 23.6kg/m^2 and 28.6kg/m^2 were found to be equivalent to 25 and 30 for Caucasians when used to classify individuals as “overweight” and “obese”. These results support the use of recently proposed Asia-Pacific classification (WHO/IASO/IOTF 2000) that has lower BMI values to classify individuals into “overweight” and “obese” categories in young Japanese males, rather than the WHO classification that has been used as the universal classification for all populations (WHO 1997a).

The current research also showed that the body density prediction equation that has frequently been used for Japanese males cannot be applied for Japanese males. The study showed underestimation of %BF for Japanese males when the body density prediction equation developed by Nagamine and Suzuki (1964) was used. The equation by Durnin and Womersley (1974) was a better predictor for both the Japanese and Australian Caucasian male subjects. As the application of inappropriate prediction equations may increase the risk of prediction error, a new, and more accurate, set of prediction equations were developed. Based on the findings of this study using the results from DXA and anthropometry, the following new %BF prediction equations for Japanese and Australian Caucasian males are proposed;

Japanese: %BF = 0.376 + 0.402(abdominal) + 0.772(medial calf) + 0.217(age),
(R^2 = 0.786, SEE = 2.69)

Australians: %BF = 2.184 + 0.392(medial calf) + 0.678(supraspinale) + 0.467(triceps), (R^2 = 0.864, SEE = 2.37)

Minimising the number of prediction equations used to estimate body composition may reduce the scope for error. Commonly a body density prediction equation is used to obtain body density values and then a further equation is used to convert the body density value into %BF using a %BF prediction equation. In this study a new one step equation detailed above has been developed and has the potential to reduce error in body composition studies.

Based on the results of the body composition studies, it can be stated that the hypothesis was not accepted.

<u>Lifestyle</u>

1) ***H_O: Aspects of lifestyle such as dietary behaviour and physical activity do not differ across ethnic background and country of residence.***

Dietary intakes, physical activity patterns and other lifestyle factors were measured in all of the groups. In comparison with Japanese males (36.8% JA group and 38.1% JJ group respectively), 76.4% of Australian Caucasian males have paid more attention to what they are eating. Australian males were also involved in physical activity more frequently (98.6%) than Japanese counterparts (Japanese living in Japan = 85.7%; Japanese living in Australia = 72.1%). No differences in eating habits and frequency of involve in physical activity between the JA and the JJ groups were observed from the lifestyle questionnaire. From the results, it can be suggested that Japanese males have a fewer healthy eating practices (eg, eat three meals a day less often) and physical activity than Australian Caucasian males and their attitudes were unlikely to be affected by their place of residence.

From the four-day dietary records, ethnic differences in energy and nutrient intakes were observed. Australian Caucasian males consumed significantly greater intakes in energy and many nutrients than Japanese males (Energy intake of Australians = 11096.2 ± 2436.8kJ; Japanese living in Australia = 8533.5 ± 1868.0kJ; Japanese living in Japan = 9171.3 ± 2190.2kJ). In addition, the EI/BMR ratio of Australian Caucasian males was greater than Japanese males. The results may reflect ethnic differences, which include differences in body size, in energy requirements and also cultural differences in type and amount of food that each study group consume. The influence of cultural patterns was apparent on nutrient intakes and can be seen in from the differences in energy contribution from major nutrients (ie, protein, carbohydrate, and fat) between the JA group (Protein: 16.3%, Carbohydrate: 47.3%, Fat: 32.3%) and the JJ groups (Protein: 14.4%, Carbohydrate: 50.4%, Fat: 28.1%). The JA group also had increased intakes of calcium, iron, dietary fibre, and niacin equivalent compared with the JJ group. These changes in nutrient intakes may indicate a change in their diet to a more Westernised pattern.

The JA group was found to have the lowest EI/BMR ratio among the study groups. The level was significantly lower than that of the AA group, reflecting lower rates of energy expenditure. This result was confirmed when the exercise patterns of both groups was compared using the lifestyle questionnaires.

This hypothesis has been partially accepted see discussion above.

Body image

1) ***H_O: There is no difference in the subjective body image possessed by males of different ethnic backgrounds.***

The results of this study showed that Australian males and Japanese males living in Australia compare their own physiques with the physiques of other people in the media and those on the street more frequently than the JJ subjects. Regardless of ethnicity, all males would like to have a physique that has a greater muscle mass and smaller fat mass than what they perceived as having currently. There was also a consistent trend across ethnic groups for individuals who perceived themselves to having either a small amount of body fat or muscle mass, to select an ideal physique with a greater amount of body fat or muscle mass. Similarly, individuals who perceived themselves to have a large amount of either body fat or muscle mass tend to select an ideal physique with a smaller amount of body fat or muscle mass. The study also found that Australian Caucasian males reported more frequent use of diet supplements, such as protein or creatinine, than Japanese males, showing greater effort to achieve muscle mass by Australian Caucasian males compared with their Japanese counterparts.

The current study did not find significant group differences in body acceptability, a range of physique which individuals may perceive “too thin” or “too fat”. However the lack of significant results may be because of limitation of the assessment tool (ie, the Somatomorphic Matrix) which is documented in the Results Chapter.

Based on the results of this study, this hypothesis has been accepted.

2) ***H_O: There is no difference in body perception and satisfaction in relation to one's own body composition regardless of ethnicity and a country of residence.***

Body satisfaction was not strongly correlated with the measured body composition of males regardless of their ethnic backgrounds. This indicates that the perceived body composition of males may not be based on their actual body composition.

Differences in body perceptions of "heaviness" and "fatness" were assessed in relation to the measured values. For assessment of "heaviness", the BMI was used as the indicator and for assessment of "fatness", %BF and sum of skinfolds were used as the objectives measures. Both ethnic groups showed moderate agreement between the BMI and their perceived "heaviness" but lower level of agreement between their %BF and their perceived "fatness". Japanese males tend to overestimate their body fatness and heaviness whereas Australian Caucasian males underestimate themselves. The BAQ scores indicate that Japanese males tend to have pessimistic body perceptions whereas Australian Caucasian males possess optimistic characteristics, which may explain the observed ethnic differences in body perception. In addition, a greater proportion of the JA group was found to have distorted body image in relation to their body composition than the JJ group. This may be a consequence of living in a society where they exposed to a wide range of physiques compared with people living in Japan.

No ethnic differences in body satisfaction in relation to body composition indicate that this hypothesis has been accepted. However, Japanese overestimated their level of "heaviness" and "fatness" while Australian Caucasian males underestimated their level of heaviness and body fat content. A presence of these ethnic differences in body perception suggests that this hypothesis has only been partially accepted.

3) ***H_O: There is no difference in body image responses and the risks of developing health problems across ethnicity and a country of residence.***

The JJ group tended to overestimate their own body weight. Also the JJ group showed a correlation between body mass and the dieting subscale score of the EAT. Consequently, they may be at higher risk to commit themselves to unnecessary dieting or eating behaviours, including not eating meals properly. In comparison, Australian Caucasian males may have increased risk of becoming overweight because of their optimistic view about their own level of fatness. The JA group overestimated their own "heaviness" and "fatness", which is similar to the JJ group. However, the JA group had lower correlations between anthropometric variables and the EAT scores compared with the JJ group. Together with results obtained from the lifestyle assessment questionnaires, the JA group showed lower risks of becoming overweight than the AA group and also of unnecessary dieting behaviours than the JJ group.

However, a combination of dietary shift to more Westernised pattern of the JA group, as well as low level of physical activity and poor awareness on their eating behaviours may lead to health problems including unnecessary weight gain among individuals who stay in Australia for a longer period. If they are at ease with their physique or perceived body shape even after their return to Japan, they may remain as a group of low disordered eating risk. However, if their body image shifted back to the one similar to the JJ group, it is possible that their pessimistic perception toward themselves would increase the risk of the JA group to undergo dieting behaviours including disordered eating behaviours. This could only be ascertained by a longitudinal study of the effect of returning home to Japan of Japanese who have lived overseas.

In this study differences were found in perceptions of body image and the responses to the eating disorder questionnaires. These indicate that the JJ group may be more at risk of disordered eating and the AA group may be more at risk of becoming obese. The JA group may be at a lower risk if they are staying in Australia for a short-term but may increase a risk of becoming obese in long-term. The JA individuals also may be at a greater risk of disordered eating after their return to Japan. For these reasons this hypothesis was not accepted.

In addition, following hypotheses were considered as part of the research project:

1) ***H_O: the body image assessment instrument 'the Somatomorphic Matrix' is applicable for multiple ethnic populations.***

Japanese and Australian Caucasian males were asked to select their perceived "own" image from the Somatomorphic Matrix computer program (SM). The body composition values associated with these images in the SM program were then compared the subjects' actual body composition values as measured by DXA. The results showed that the body composition values obtained from the SM program do not reflect the actual body composition of subjects. Consequently, all body composition values obtained using the SM program cannot be accepted as the values which to the subjects would like to have in reality. The program however, may be applied to observe group differences in body image while acknowledging the limitations of its body composition values.

Consequently, this hypothesis has been accepted, subject to the limitations noted above.

2) ***H_O: Japanese-translated questionnaires have validities equivalent to the original questionnaires.***

In this study, the Ben-Tovim Walker Body Attitudes Questionnaires (BAQ) and the Attention to Body Shape Scale (ABS) were translated into Japanese and applied to examine ethnic differences in body concerns. As there have been no reported studies on the applicability of these questionnaires to males, results obtained from this study were compared with previous study results which used female subjects (Ben-Tovim & Walker 1991; Beebe 1995). The results of both Japanese and Australian Caucasian males showed good internal consistency for both BAQ and ABS questionnaires, which were equivalent levels to the previous studies using females. Japanese also showed good test-retest reliability for both questionnaires whereas Australian Caucasian males showed significant differences in their BAQ scores at the baseline and the 12-months follow-up assessments. The study found that Japanese males had high scores in the self-disparagement subscale and in the lower-body fatness subscale than Australian males. In comparison, Australian males were more confident about their strengths and attractiveness than Japanese males.

The BAQ and ABS scores were compared with the Eating Attitudes Test (EAT), a questionnaire which has frequently been used as a screening tool of disordered eating. The results showed that both BAQ and ABS scores were correlated with the EAT total and subscale scores in all study groups. In addition, it was found that Australian Caucasian males had higher EAT total score as well as dieting subscale score than Japanese counterparts.

From the results, this hypothesis has been accepted and both the BAQ and the ABS questionnaires can be used in both Japanese and Australian Caucasian males.

There were no major differences between the results of the baseline assessment and the follow-up assessment conducted after 12 months.

6.2 Implications of this study

The findings of the current study provided information at may have important implications for public health programs, particularly in the prevention of obesity and unnecessarily disordered eating.

1. Ethnic differences in the BMI cut-off points

Because of its simplicity, one of the important screening tools will be the BMI. However, it is important to use the cut-off points that reflect the actual body fat levels of the population being assessed. This study has identified lower cut-off points for Japanese males that correspond to the WHO assessment levels.

The currently available Japanese-specific BMI classification was proposed by the JASSO, based on consideration of the WHO classification and Japanese studies using an older population suggesting correlations between the BMI values and a development of chronic diseases such as diabetes and cardiovascular diseases. The JASSO classification was however, did not consider difference in health risk among younger Japanese population and did not consider a relationship between the BMI and %BF of individuals.

The current study proposed the use of revised BMI classification for Japanese males, similar to the Asia-Pacific classification but different from the JASSO and the WHO classifications.

2. New %BF prediction equation for Japanese

The current study also showed that the body density prediction equation which has been used to predict %BF of Japanese males were not applicable to Japanese males living today. Application of prediction always involves with prediction error and therefore it is important to use the equation that is "population-specific". However, this study indicated that even though the equation was developed from same ethnic group, the equation developed 40 years ago is no longer applicable.

This study proposed new %BF prediction equation from body composition assessments using anthropometry and DXA. Equations given above (see Results Chapter, Table 4.1.4) are not only the equations developed from advanced method (ie, DXA), but also no need to convert body density into %BF hence reduces involvement of prediction error compared to the previous equation. Although the applicability of the equations needs to be confirmed using larger sample size, it is recommended to use a equation with less involvement of error to predict body composition of the study group.

3. Difference in nutrient intakes between Japanese living in different countries

The current study showed the JA group consumed more Westernised diet than the JJ group. Although the JA group showed increase in intakes of calcium, iron, dietary fibre and niacin equivalent, the JA group consumed greater proportion of energy from fat and protein and fewer amounts from carbohydrate than the JJ group. Considering lower EI/BMR of the JA than the JJ group, the JA may not experience significant health problem in short-stay in Australia. However, continuation of high energy consumption from fat may be a risk factor for health for the JA group. Consequently it may be beneficial to provide sufficient advice to the JA subjects in order to reduce their health risk.

4. Differences in body image between the study groups

The current study found similarity in perceived “current” and “ideal” body image between Japanese and Australian Caucasian males. Also both groups showed incorrect body perception in relation to their actual body composition and further, showed that Japanese overestimate their level of “heaviness” and “fatness” whereas Australians underestimate themselves. Their differences in body perception may be explained by the difference in scores obtained from the self-disparagement subscale, the strengths subscale, and the attractiveness subscale of the BAQ questionnaire. Furthermore, the study showed that the JJ group may commence dieting behaviours by judging themselves from their body mass. These findings indicate that it is important to acknowledge not only if they have correct body image but also the ethnic differences in the way the groups perceive themselves and possible factors which they use indicators to commence unnecessary, unhealthy behaviours.

5. Body image and public health

The topic of body image has been commonly assessed in relation to psychological or mental disorders. However, there are a very limited number of reported public health studies that incorporated issues of body composition, lifestyle, and body image simultaneously.

By appropriate assessment of individuals with appropriate individual feedback, it may be possible to assist a formation of a healthy body image, including body perception that reflects their actual body composition. This may reduce unnecessary concern or encourage physical activities to maintain health status. However before the assessment of body image is advocated as a screening tool to determine potential health risks status, further research is required. This would include longitudinal studies to assess sensitivity and specificity and “number needed to treat”.

Once body composition information has been obtained from these methods, health professionals can give appropriate advice. As shown in the study, Japanese males overestimate their level of fatness. In addition, Japanese males were likely to not alter their attitudes toward healthy eating practices and involvement in physical activity as measured by the lifestyle questionnaires even change in their living environment occurred. Hence it may be important to reassure young Japanese adults about their current physical condition. It may be useful to seek methods to raise their motivation to reduce their body fat in the case of being overweight. For Australian males, who tend to have a more optimistic body image (ie, underestimate their own level of fatness), providing adequate body composition and health risk information may encourage them to exercise. In addition, as many Australian males are preoccupied with muscle gain, providing opportunities for follow-up assessment of their body composition and dietary advice may in assist motivating them to continue their exercise programs.

The current study showed ethnic differences in body image between Japanese and Australian Caucasian males. The study also indicated that Japanese males who spend time away from Japan may reduce risk of developing disordered eating as well as overweight or obese during their stay in overseas, as measured by dietary records, the lifestyle and the EAT questionnaires. However this risk may be modified again by their change to the consumption of an energy dense Westernised diet, and longer stay Japanese subjects may be at a risk of weight gain. In the longer term, Japan will become a more multi-ethnic society and there will be an increased chance of exposure to a variety of physiques within Japan. In this case it is possible to speculate that, unless the lifestyle of Japanese traditional diet and a regular exercise are maintained, the risk of overweight and obesity among Japanese males is likely to be increased.

The findings of the current study suggested a presence of distorted body image among Japanese and Australian Caucasian males. To reduce a risk of developing any related health problems, such as becoming obese, both Japanese and Australian Caucasian males could benefit from improvement of their body image, ideally to reflect their actual body composition rather than their visual appearance or just body mass. To improve body image of both Japanese and Australian Caucasian males, the incorporation of the concepts of body image and body composition into health education programs from childhood should be considered and trialled. Potentially this may lead to a reduction of unnecessary dieting behaviours as well as increase in motivation to maintain a health body composition throughout their lifetime.

6.3 Limitations of the study

This study has several limitations that need to be considered. Because of the limitations of time and resources the study had to be rather short-term in nature. Longer- term longitudinal studies could be used to confirm the results of this study and to sue endpoints that include morbidity.

This is the first study that ethnic differences in BMI-%BF relationship has been reported for young Japanese males. In future research, it would be ideal to re-assess the BMI-%BF relationship using an equivalent sample size by advanced body composition assessment methods, such as DXA. In addition, this study has proposed %BF prediction equations for both Japanese and Australian Caucasian males. The applicability of these equations to other age groups would need to be tested before their general adoption.

The BMI cut-off points for the assessment of obesity status based on %BF should be tested with long-term population studies to determine their relationship to actual morbidity and mortality.

The current study indicated both similarities and differences in aspects of body image between Japanese and Australian Caucasian males. Also the study showed differences in relationship between body image and body composition between the study groups, which may suggest differences in health risks. In order to clarify the mechanism, future studies should incorporate detailed psychological assessment as well as detailed health assessments and body composition assessments.

It is recommended that further research be conducted on the Somatomorphic Matrix computer program (SM), and the translated questionnaires such as the BAQ, and the ABS prior to their applications to both genders and a wider age range of Japanese population. Especially for the SM program, the improvement of the program as well as the development of advanced body image assessment program is recommended and may expand possibility of its application in clinical situations, as a screening tool, and also as an educational instrument.

6.4 Recommendations for future research

To date, this is the first cross-ethnic, cross-cultural study from the perspective of public health, nutrition, and kinanthropometry that aimed to link issues of body composition, lifestyles, and body image using Japanese males. Consequently, there is a lack of other studies that allow comparison of results obtained from this study. To assess and evaluate the study results, it is recommended that more cross-ethnic and cross-cultural studies be undertaken to examine the risk of health problems such as obesity and disordered eating in relation to body composition and body image.

This study successfully obtained the results from the baseline and 12-months follow-up assessments for the JJ and the AA groups. However, in order to detect precise cultural influences on body composition and body image, longer term follow-up should be considered in future studies. The current study indicated a possible health risk among the JA group after their long stay in Australia and those who returned to Japan. In order to examine an impact of travel abroad and being exposed to different cultural society to their body image formation and future health risk, follow-up assessment of the JA subjects after their return to Japan may provide information to answer the question.

6.5 Conclusion

The aim of this research was to determine ethnic and cultural influences on body composition, lifestyle, and aspects of body image using Japanese and Australian Caucasian males living in Australia and also Japanese males living in Japan.

From detailed body composition assessments such as anthropometry and DXA, significant ($p<0.05$) ethnic differences in body composition and subcutaneous fat distribution were found. The study also found significant ($p<0.05$) ethnic differences in the %BF at given BMI levels. For Japanese males, the BMI values of 23.6kg/m^2 and 28.6kg/m^2 were found to be equivalent to 25 and 30 for Caucasians when used to classify individuals as "overweight" and "obese". New regression equations that represent BMI-%BF relationships for Japanese and Australian Caucasian males were proposed:

Japanese: Log %BF = -1.330 + 1.896(log BMI), (R^2 = 0.547, SEE = 0.09);
Australians: Log %BF = -1.522 + 2.001(log BMI), (R^2 = 0.544, SEE = 0.10)

At the same time, new %BF prediction equations for Japanese and Australian Caucasian males were proposed using the body composition results obtained from anthropometry and DXA:
Japanese: %BF = 0.376 + 0.402(abdominal) + 0.772(medial calf) + 0.217(age), (R^2 = 0.786, SEE = 2.69);
Australians: %BF = 2.184 + 0.392(medial calf) + 0.678(supraspinale) + 0.467(triceps), (R^2 = 0.864, SEE = 2.37).

From the results obtained from the lifestyle questionnaires and the dietary records, Australian males participate in physical activity (98.0%) more frequently than their Japanese counterparts (Japanese living in Japan = 85.7%, Japanese living in Australia = 72.1% respectively). In addition, greater consumption of energy from protein and fat by the JA (Protein: 16.3%, Carbohydrate: 47.3%, Fat: 32.3%) and the AA groups (Protein: 17.1%, Carbohydrate: 47.9%, Fat: 30.6%) compared with the JJ group (Protein: 14.4%, Carbohydrate: 50.4%, Fat: 28.1%). This shows that the Japanese living in Australia have adopted a more westernised diet than those living in Japan.

Differences in body image between Japanese and Australian Caucasian males were assessed using questionnaires such as the BAQ, the ABS, and the EAT and the Somatomorphic Matrix (SM) computer program. Japanese males tended to overestimate their weight and amount of body fat, while Australian Caucasian males underestimated these parameters. Both the BAQ and the ABS questionnaires were found to be applicable to both Japanese and Australian Caucasian males. The Japanese groups had higher scores on the self-disparagement subscale and lower scores on the strengths and the attractiveness subscales of the BAQ questionnaire than Australian males. From the current study, the results obtained from the SM program had no relationship with measured body composition values obtained from a detailed body composition assessments. Further development of this program is recommended in order to improve its validity and applicability in cross-ethnic or cross-cultural studies.

From the findings, it can be suggested that Japanese males living in Japan may be at the highest risk of developing disordered eating, and groups living in Australia have more risk to become overweight or obese. Because of more Westernised diet they consume, Japanese living in Australia was concerned for unnecessary weight gain during their stay in Australia. However, because of their low EI/BMR ratio it is unlikely individuals who are staying in Australia to become overweight or obese. However, due to a combination of their pessimistic perception toward own body and their frequent exposure to a range of physiques of different ethnic backgrounds, the JA subjects showed a greater distorted body perception than the JJ group. However, due to their exposure to different physiques, the JA subjects were likely to become tolerant with their own physique compared with the JJ group. Consequently they may reduce a risk of unnecessary dieting behaviours in comparison with the JJ subjects as long as they are living in Australia.

It has been suggested that distorted body image may be associated with a development of avoidable health problems, including eating disorders and obesity. From the study result, a poor understanding of one's own body composition may be a one of the variables that lead to a development of these problems. Consequently, a promotion of correct and healthy body image that reflects one's actual body composition can be suggested as an important issue in order to reduce a proportion of individuals who may develop health problems. The variables that influence on one's body composition and the formation of body image vary between individuals, particularly between different ethnic backgrounds and their living environment. Therefore, it is important to acknowledge ethnic differences in psychological characteristics and provide appropriate advice after obtaining comprehensive information of individuals, including their detailed body composition data and lifestyle information.

Chapter 7 - References

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Appendix One. Advantages and disadvantages of body composition assessment methods

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Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
1 (Direct)	Cadaver dissection	Chemical: protein, fat, water, and minerals Anatomical: skin, muscle, adipose tissue, bone and residuals	Not applicable	High	No	It can assess body composition directly hence most accurate method. Time after death needs to be considered to obtain valid results.	Reliable but the caution is required that the result is population-specific	Clarys, et al. 1987

Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
2 (Indirect)	Underwater weighing	Body density	Safe	Low	No	Densities of body components vary depending on study groups, which lead to a variation in %BF estimation.	Day-to-day variation of 0.0015 to 0.0020g/ml is expected	Lohman, 1981, Johansson, et al., 1993 Going, 1996, Withers, et al. 1996
	Isotope dilution	Body fluid volume	Radiation involved in some tracer used	High	No	Dependent on the tracer used. Hydration variability of the FFM (0.5-2%) could cause error in %BF estimation (~3.6%).	Depend on the dose of tracer given. Test-retest showed 1% variability	Schoeller, 1996, Heyward, 1998, Wagner and Heyward, 1999

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Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
2 (Indirect)	Total body potassium	Total body potassium content	Safe	High	No	Highly correlated with DXA ($r^2 = 0.77$) and Total body water ($r^2 = 0.72$). It does not provide best measure of the FFM.	Precision ranged from 2-5% for adults	Jensen, et al., 1993 Ellis, 1996
	Dual energy x-ray absorptiometry	Bone mineral content, fat mass, lean body mass, residual mass	Radiation involved	High	No	Hologic and Lunar made DXA showed close values with underwater weighing, 4-compartment model, BIA, total body water, and anthropometry.	Coefficient of variation of short-term precision ranged from 0.9-3.8%	Pritchard, et al., 1993, Wellens, et al., 1994, Lohman, 1996, Fogelholm and Lichtenbelt, 1997

Appendix One. Advantages and disadvantages of body composition assessment methods

Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
2 (Indirect)	Nuclear magnetic resonance	Lean and adipose tissue	Magnetic exposure involved	High	No	High correlations with fat of fat (r = 0.97) and pig (r = 0.98). 6% difference in adipose tissue estimation by the cadaver dissection. SEE ranged from 2-10%.	Coefficient of variation of whole body fat is expected to be about 5-7%. For a visceral adipose tissue, error of about 10% is expected.	Jebb and Elia, 1993, Despres, et al., 1996
	BOD POD® (Air displacement method)	Body density	Safe	High	No	Correlations with DXA = 0.91 With underwater weighing =0.96	Coefficient variation ranged from 1.7-3.47	Miyatake, et al. 1999, Wagner and Heyward 1999

Appendix One. Advantages and disadvantages of body composition assessment methods

Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
3 (Doubly indirect)	Ultrasound	Subcutaneous adipose tissue	Safe	Low	Yes	Comparison with cadaver analysis: (r = 0.968 for fat, r = 0.996 for muscle), skinfolds: (r = 0.80 and over).	High repeatability (r = 0.87-0.98). Coefficient of reliability generally high (91-98%)	Lukaski, 1987, Roche, 1996, Abe and Fukunaga 1995
	Anthropometry	Body geometry, FM, FFM, body density, and %BF from the measurements of stature, body mass, skinfold, girths, bone lengths and bone widths.	Safe	Low	Yes	High correlation in prediction of %BF with DXA (r = 0.95, SEE = 2.54). From a cadaver analysis, high correlation between internal and subcutaneous fat (r = 0.75 for males, r = 0.89 for females)	Reliability depends on skill of technician, measurement protocol, equipments and the prediction equation used.	Martin, et al., 1985, Svendsen, et al., 1990, Roche, 1996, Heyward, 1998, Wagner and Heyward, 1999

Appendix One. Advantages and disadvantages of body composition assessment methods

Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
3 (Doubly indirect)	Bioelectrical impedance analysis	Total body water, fat free mass, percent body fat	Safe	Low	Yes	Depending on the prediction equation used. High correlations with total body water (r =0.95), total body potassium (r = 0.96), underwater weighing (r = 0.98), and DXA (r = 0.79-0.82). SEE of 1.4-3.5kg total body water and 2.0-3.6kg FFM are expected. Overestimates %BF of subjects with long limbs.	Day to day variability 1-2%. High reliability regardless of gender (r = 0.97-0.99) Detecting changes <1-2kg is below he precision of whole body BIA.	Jackson, et al., 1988, Svendsen, et al. 1991, Kushner, 1992, Pritchard, et al. 1993, Fogelholm and Lichtenbelt 1997, Wagner and Heyward 1999, Snijder, et al., 1999

Appendix One. Advantages and disadvantages of body composition assessment methods

Level	Method	Measuring component	Safety	Cost	Portability	Validity	Reliability	References
3 (Doubly indirect)	Anthropometric indices (BMI, WHR)	Heaviness, central adiposity, health problem risks	Safe	Low	Yes	While it shows high correlations with various health problems, the BMI does not associate with the actual body composition of individuals. The BMI cut-off points for obesity also vary depending on the ethnic background of each subject. Increase in WHR highly correlated with increase in fat deposition in the trunk region and also correlated with a health risk.	The BMI and the WHR values represent proportions of stature and body mass and waist and gluteal girths hence as long as the measured values are same, the BMI and the WHR values are always same.	Ross, et al., 1988 Heitmann, 1990, Stevens, et al., 1998, Snijder, et al., 1999, Matsuzawa, et al., 2000, WHO/IASO/ IOTF, 2000, Deurenberg, et al., 2002, Dalton, et al., 2003, Welborn, et al., 2003

Appendix Two. Variables that influence on formation of body image

Appendix Two. Variables that influence on formation of body image

Categories	Suggested causal factors	Detail
Environmental	**- Media**	- Promotes “thin ideal” for females and “muscular ideal” for males (Spillman & Everington 1989; Davis & Oswalt 1992; Myers Jr. & Biocca 1992; Cusumano & Thompson 1997; Turner et al. 1997).
	- Family	- Family members who are dieting or male members (ie, father or brothers) often reinforce preoccupation toward body image (Striegel-Moore & Kearney-Cooke 1994; Usmiani & Daniluk 1997; Agras, Hammer & McNicholas 1999).
	- Education	- Appropriate education can decrease unnecessary body dissatisfaction and disordered eating (Touyz et al. 1994; Springer et al. 1999) but it can also reinforce body image distortion (Davis & Oswalt 1992).
	- Peer relationship	- Peer pressure and relationships affects behaviour and body image values including body satisfaction (O'Dea 1994; Thompson 1995; Garner 1997).
	- Food availability	- Desire to be thin can only occur in a society with sufficient food supply. Difference in ideal body image often associated with food availability as food accessibility can be often viewed as a sign of wealth, which becomes a part of cultural value (Brown & Konner 1998).

Appendix Two. Variables that influence on formation of body image

Categories	Suggested causal factors	Detail
Personal	**- Gender**	- Females are suggested to have more dissatisfied and distorted body image than males (Dwyer et al. 1969; Abraham et al. 1983; Crawford & Worsley 1988). Males tend to split into two groups; the one wish to gain weight and others wish to lose weight (Dolan, Birtchnell & Lacey 1987; Cohane & Pope Jr 2001).
	- Body appearance/physique	- Difference in possessing body image depending on their physique, including frame size has been reported (Glucksman & Hirsch 1969; Craig & Caterson 1990; Rand & Kuldau 1990; Davis et al. 1994).
	- Past history (eg, abuse, obese, drug use)	- Past history of any shape of abuse may affect one's satisfaction toward own body through physical, emotional or psychological damages (Thompson et al. 1995; Garner 1997). Use of drugs including anabolic steroid may also interferes with body image development (Schwerin et al. 1996). Individuals with past history of obesity may overestimate themselves due to their "Phantom body size" even after successful weight loss (Glucksman & Hirsch 1969; Foster et al. 1997). This finding is still yet to be confirmed, as studies with opposing result exist.
	- Sensory function	- One study concluded that there may be an association in body size overestimation and general visuo-spatial dysfunction (Thompson & Spana 1991). Others comparing perceptions of objects and body parts stated that each perceptions are relatively independent to each other thus body perception disorder cannot be accounted for by a general perceptual disturbance (Slade & Russel 1973; Hundleby & Bourgouin 1993).

Appendix Two. Variables that influence on formation of body image

Categories	Suggested causal factors	Detail
Personal	**- Psychological function**	- Poor psychological status such as high levels of depression, anxiety and low self-esteem are associated with severe body image distortion and high body dissatisfaction (Thompson & Thompson 1986; Brenner & Cunningham 1992). The relationship between body image and psychological status itself is not a one direction mechanism but apparently a two-way mechanism (Thompson et al. 1995; Meijboom et al. 1999; Wiederman & Pryor 2000).
	- Physical activity level	- Individuals with regular physical activity have higher body satisfaction level than those without consistent exercise (Paxton et al. 1991; Williams & Cash 2001). Athletes have different body image depending on type of sports they participate (Enns, Drewnowski & Grinker 1987).
	- Socioeconomic status (SES)	- No clear consistent relationship has been reported yet (O'Dea 1994; Tiggermann & Pickering 1996).

Appendix Two. Variables that influence on formation of body image

Categories	Suggested causal factors	Detail
Maturation	**- Aging and biological growth**	- While there is no consistent result in relationship between body image and age (O'Dea 1995; Stevens & Tiggemann 1998), biological growth, such as menarche, suggested a clear impact on body image change (Altabe & Thompson 1990; Carr-Nangle et al. 1994).
	- Gender role identity	-Development of sexuality may alter body image and weight control behaviors (Usmiani & Daniluk 1997).
Cultural	**-Ethnicity**	- Ethnic differences in body image and related behaviours were reported (O'Dea 1998; Ogden & Elder 1998)
	- Socio-cultural values	- Western cultural values reinforce thin-ideal images rather than other cultural values (Garner et al. 1980; Fallon 1990; Wiseman et al. 1992).
	- Social pressure	- Stereotype of being obese, low self-management skill and peer pressure for dieting may encourage individuals with distortion of body image (Abraham et al. 1983; Craig & Caterson 1990; Levine et al. 1994; Cusumano & Thompson 1997).
	- Westernization	- Those exposed to western cultural values have greater feeling of body dissatisfaction and desire for thinness than those without exposure (Furnham & Alibhai 1983; Desmond et al. 1989; Furnham & Baguma 1994; Wilkinson, Ben-Tovim & Walker 1994; Craig et al. 1996).
	- Acculturation/Assimilation	- Relationships between degree of assimilation to western culture and body image, eating behaviour and risk of eating disorders have been suggested (Abrams, Allen & Gray 1993; Flynn & Fitzgibbon 1998; Davis & Katzman 1999)

Appendix Three. Classification of eating disorders according to DSM-IV®-TR

Appendix Three. Classification of eating disorders according to DSM-IV®-TR

Category	Criteria
Anorexia Nervosa (AN)	A. Refusal to maintain body weight at or above a minimally normal weight for age and height (eg, weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected). B. Intense fear of gaining weight or becoming fat, even though underweight. C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight. D. In postmenarcheal females, amenorrhea, ie, the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, eg, estrogen, administration.) Subtypes: **Restricted Type:** during the current episode of Anorexia Nervosa, the person has not regularly engaged in binge-eating or purging behaviour (ie, self-induced vomiting or the misuse of laxatives, diuretics, or enemas) **Binge-Eating/Purging Type**: during the current episode of Anorexia Nervosa, the person has regularly engaged in binge-eating or purging behaviour (ie, self-induced vomiting or the misuse of laxatives, diuretics, or enemas)

Appendix Three. Classification of eating disorders according to DSM-IV®-TR

Category	Criteria
Bulimia Nervosa (BN)	A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following: (1) eating, in a discrete period of time (eg, within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances (2) a sense of lack of control over eating during the episode (eg, a feeling that one cannot stop eating or control what or how much one is eating) B. Recurrent inappropriate compensatory behaviour in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise. C. The binge eating and inappropriate compensatory behaviours both occur, on average, at least twice a week for 3 months. D. Self-evaluation is unduly influenced by body shape and weight. E. The disturbance does not occur exclusively during episodes of Anorexia Nervosa. Subtypes: **Purging Type:** during the current episode of Bulimia Nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas **Nonpurging Type:** during the current episode of Bulimia Nervosa, the person has used other inappropriate compensatory behaviours, such as fasting or excessive exercise, but has not regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas
Eating disorder not otherwise specified (EDNOS)	The Eating Disorder Not Otherwise Specified category is for disorders of eating that do not meet the criteria for any specific Eating Disorder.

(Adopted from DSM-IV®-TR, 2000)

Appendix Four. Prevalence and Incidence rates on eating disorders

Appendix Four. Prevalence and Incidence rates on eating disorders

Researchers	Year	Country	Sample characteristics	Study design	Rate
Crisp, et al.	1976	England	Schoolgirls (n = 12,391) 15 years and under = 8,274 16 years and over = 4,107	Cross-sectional	Prevalence of anorexia nervosa; Total = 4.6 per 1,000 Girls under 15 = 1.7 per 1,000 Girls 16 and above = 10.5 per 1,000
Patton.	1988	England	Patients with eating disorders between 1971-1981 (n = 460) 4.1% male Anorexia Nervosa = 332 Bulimia Nervosa = 96 Other eating disorders = 32	Longitudinal (4-14 years follow-up)	Expected mortality rate; Anorexia Nervosa = 1.83 Bulimia Nervosa = 0.32 Other = 0.12 Total = 2.27 Standardized mortality ratio Anorexia Nervosa = 6.01 Bulimia Nervosa = 9.38 Total = 6.17
Ben-Tovim, and Morton.	1990	Australia	5,705 girls aged 12-18 years old	Cross-sectional	Prevalence rate of anorexia nervosa; 1.05 per 1,000 females Incidence rate of anorexia nervosa; 0.177 per 1,000 females

Appendix Four. Prevalence and Incidence rates on eating disorders

Researchers	Year	Country	Sample characteristics	Study design	Rate
Lucas, et al.	1991	USA	181 subjects screening from 13,559 medical records according standard diagnostic criteria (166 females, 15 males)	Cross-sectional	Overall age-adjusted incidence rate of anorexia nervosa; Females = 14.6 per 100,000 Males = 1.8 per 100,000 Overall age-adjusted prevalence rate of anorexic nervosa; Females = 269.9 per 100,000 Males = 22.5 per 100,000
Crisp, et al.	1992	England	105 females at St. George's 63 females at Aberdeen	Longitudinal (mean of 20 year follow-up)	Crude mortality rate of anorexia nervosa; St George's = 4% Aberdeen = 13% Standardized mortality ratio St George's = 1.36 Aberdeen = 4.71
Eckert, et al.	1995	USA	76 females	Longitudinal (10 year follow-up)	Crude mortality rate of anorexia nervosa = 6.6% Standardized mortality ratio = 12.82
Sullivan.	1995	-	3,006 individuals	Meta-analysis from 42 published studies	Crude mortality rate of anorexia nervosa = 5.9%
Keel, et al.	1997	-	2,194 individuals	Meta-analysis from 88 published studies	Crude mortality rate of bulimia nervosa = 0.3%

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Furnham, A. Alibhai, N. (1983)	-Kenyan Asian (mean age 24) -Kenyan Asian in Britain (mean age 23.4) -British Women (mean age 22.5) Females 15 subjects per group	-Showing 12 sketches of naked female shapes in random order, ranging from extreme anorexic to extreme obese -Rate each picture with 13 constructs with 7-points scale	-Kenyan Asians were heavier and larger than other groups -Longer spend in Western society, lesser obese -No difference in the subject's self perception in terms of attractiveness, confidence and feminine -Kenyan Asians perceived fat shapes positively -Kenyan British and British Whites rated moderately thin as positive figure than Kenyan Asians.	-Small sample size -No representative sample
Dawson, D. A. (1988)	-Blacks (n =1,955) -Hispanics (n = 985) -White (n = 14,330) Aged 18 and over All females	-Retrospective study using 1985 National Health Interview Survey (NHIS) -Self reported height and weight for BMI calculation	-Whites are more likely to perceive as being overweight -Hispanics consider themselves overweight more than Blacks -Slightly more than 2/3 of all women who consider themselves overweight are trying to lose weight	-Validity of data -Use of self-report height and weight -Inappropriateness of using the BMI as an indicator of body composition

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Desmond, S. M. et al. (1989)	-Blacks (n = 138; Males = 70, Females = 68) -Whites (n = 193; Males = 92, Females = 101) Aged 14-14.3 yeas old	-22-item Questionnaire developed by the authors (reliability = 0.78)	-All heavy White females and 78% of White males perceived themselves as heavy, while only 40% and 36% of heavy Black females and males -Thin Black and White females dieting and exercising to lose weight, thin White males exercise to lose weight -While Black females believed exercise levels accounted to weight, White females believed eating habit	-Insufficient sample size for each sub-groups -Only data of students who attended on the day was collected (generalizeability) -Only available weight locus of control instrument was used -Difficulty choosing correct cut-off points and identifying standard categories -Possible misclassification as a consequence of not measuring actual bodies composition but only weight
Gustavson, C. G. et al. (1993)	-Japanese females (n = 127) -Americans (n = 395; Males = 100, Females = 295) -Costa Ricans (n = 286; Males = 140, Females = 146)	-Computer-based image-analysis	-Observed reliable negative relationship between body image distortion and subject's stature -No reliable difference was observed between sex and cultural groups	-No detailed information on: method, subjects, analysis method, direction of body image distortion

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Wilkinson, J. Y. et al. (1994)	-Samoan (n = 70) -Australian (n =70) Selected from broader range of socioeconomic groups Pair matched for weight, height and age (20-56)	-BAQ	-Pair matched well except Australians older -Fatness not pre-occupying in Samoans than Australians -Samoans are more disparaging about their bodies than Australians -Large Samoan females felt more attractive, stronger, and fitter than Australians	-Wide age range -Sample size may not be sufficient -Unable to assess environmental factors e.g. SES and diet -No justification of their accuracy in perception
Furnham, A. Baguma, P. (1994)	-British (n = 75; Males = 28, Females = 47; mean age = 21.3) -Ugandan (n = 106; Males = 55, Females = 51; mean age = 22.3)	-24 slides of naked figures on a blank background (12 males, 12 females). -Booklet consisting of 12 bipolar constructs that was rated on a 7-points scale. -Subjects asked to rate each figures with constructs.	-British subjects of both genders rate fatter figures as less confident, famine, happy but more lonely -Ugandans noted figures 9-12 as healthy whereas the British group rated them as fairly unhealthy -Ugandan subjects of both genders rated obese figures as more attractive and healthy than did the British subjects	-Sample size may be insufficient -Translations provided for Ugandans unknown

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Story, M. et al. (1995)	Total = 36,320 (males = 16,852, females 17,545) -White (86%) -Blacks (8%) -Hispanics (1%) -Native Americans (2%) -Asian Americans (3%) 754 excluded from some analysis Aged 12-20 Socioeconomic status (SES): - Low (14%), - Medium (56%), - High (30%)	-Series of questions on dieting behaviours, laxatives and diuretic usage, binge eating, out of control eating, wt satisfaction, feeling about one's body, and body wt self-evaluation. -The BMI calculated	-Prevalence of dieting high among Hispanic females, lowest among Black females -Two-folds laxative/diuretic usage among Hispanic females than others -Asian females reported binge eating and out of control eating most frequently -Black and Asian females least likely to view themselves as overweight -Black females more likely to satisfy with their wt, prouder of their body, more likely as underweight compared to White females. -Dieting behaviours, negative body image perception less common among males than females -Asian males reported more dieting, binge eating, out of control eating than White male -Black males more satisfied with their wt, proud of their body -Black and Native Americans are likely to report intentional vomiting than White males -High SES associated with greater wt satisfaction and lower rates of pathological wt control behaviours -High SES reported more dieting than Low SES -Low SES less likely to perceive themselves as overweight	-No details of ethnicity and demographic information (eg, duration of residence) -No justification of their perception with their actual wt (or with BMI). -Validation of self-reports of dieting and wt control behaviours required -Not enough details on questionnaire

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Craig, P. et al. (1996)	-Polynesian Maori (n = 132; M =49, F = 83) -Australian (n = 132; M = 49, F = 83) Australian subjects matched for sex, age, and the BMI	-Questionnaire on body size perception based on distorting photograph technique -Photographs were used as the stimuli for questions-Pictures with Polynesian models were in traditional dress	-Women of both ethnic groups had similar body size preferences -Cook Islands women were the most accurate in selecting their current size Australian women overestimated -Men with the BMI<25 accurate -Preferred size increased with age. -Polynesian women with the BMI<25 were satisfied with their body size but those >25 and all Australian women dissatisfied their body size -Polynesian men preferred larger body than Australians -Polynesians chose larger figure as ideal than Australians -The range of acceptable figure narrower among Polynesian than Australian -Smaller size less acceptable for Polynesian	-Generalizeability -No detail of questionnaire -Detail of exposure to Western culture should be tested

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Lee, A. M. Lee, S. (1996)	-Chinese living in Hong Kong (n = 294) Girls from girl's school. Aged 14-19	-Eating Attitudes Test-26 -Body Dissatisfaction Scale (BDS) -The Beck Depression Inventory (BDI) -Family Environment Scale -The Body Mass Index (current, desired)	-While only 7.8% satisfied with their body shape, most not satisfied with hip, legs, waist, arms, and stomach -Sign correlation b/t EAT-26 and current BMI, BDI, BDS and BDI -Disordered eating was positively predicted by body dissatisfaction and, to a lesser extent, family cohesion and conflict -Body dissatisfaction positively predicted by depression, which was negatively predicted by family cohesion	-Possible misleading due to translation
Caldwell, M. B. et al. (1997)	-White (n = 7,200) -Black (n = 183) Females dieters aged 21-65 whose SES is high to middle class	-The Body Mass Index -Nine silhouettes tests -Rosenberg Self-Esteem Scale (RSES) -Questionnaires	-No sign difference on: 1) body dissatisfaction, self-esteem, 2) discrepancies between actual and ideal weight and shape, and 3) relationship between self-esteem and body dissatisfaction between ethnicity -SES may be more powerful determinant than ethnicity in body dissatisfaction	-Huge difference in sample size -Wide age range -No detail on questions asked -Cannot be generalized

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Altabe, M. (1998)	-African -Asian American -Caucasian -Hispanic Males = 150, Females = 185 Mean age 21	-Body Dissatisfaction sub-scale of the Eating Disorders Inventory (EDI) -The Figure Rating Scale (FRS) -The Body Image Automatic Thought Questionnaire-Positive sub-scale (BIATQ) -The Physical Appearance Discrepancy Questionnaire (PADQ) -Self-rating questionnaire including physical attractiveness and physical appearance importance	-Caucasians have more size discrepancy than Africans and Asian Americans -Hispanics showed more discrepancy than Africans -Caucasians dissatisfied with their body than Asians. Hispanics showed more dissatisfaction than Asians and Africans -All females, Asian and Caucasian males wanted to be thinner -Caucasians and Hispanics showed most disturbances with regards to weight-related body image, African and Asian the least -African had most positive self-view and Asian placed the least importance on physical appearance	-No detail in sample of each ethnic group (proportion of ethnic groups in the sample) -Needs of qualitative study

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Button, E. et al. (1998)	-Asian (n = 73; 57.5% born in Britain, 73% educated in Britain) -Caucasian (n = 130) -Black (n = 22) Aged 18-27 All females	-Posting booklet with questionnaires to subject identified by computerized records -Booklet containing: 1. Demographic information inc. SE variables and ethnicity. 2. Wt and eating, incl. dieting weight control mechanisms. 3. EAT-26 4. Rosenberg Self-Esteem Inventory (RSEI) 5.Hospital Anxiety and Depression Scale (HADS) 6.Vignettes to determine health-seeking behaviour.	-Asians were shorter, lighter and had significantly lower preferred weight -All groups wanted to be lighter i.e., 57% of the group felt too fat with no ethnic differences -No sign difference for total EAT, three EAT factor scores, Rosenberg SEI, and HADS	-Conflicting results from other studies thus needs of study considering influencing variables (eg, living condition and religion) -Small sample size for Blacks -Sampling from General Practitioners (May not be generalized)

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Ogden, J. Elder, C. (1998)	-Asians from India, Pakistan, Sri Lanka, and other) -Whites Subjects 25 mothers and 25 daughters Age: Mothers 39-60, daughters 18-26 Residents of the United Kingdom	-Structured questionnaire on ethnic group, perceived ethnic identity, body image, eating behaviour. 1) Profile characteristics 2) Acculturation -Language -Friends -Music -Radio station 3) Body image -Body Shape Questionnaire (BSQ) -Silhouettes 4) Eating behaviour -Dutch Eating Behaviour Questionnaire (DEBQ) -Calorie concern	-Asians shorter and considered themselves less Westernized -Ethnic difference in the ideal body shape but ethnicity not related to present body shape or body dissatisfaction -White daughters had the highest body dissatisfaction followed by Asian mothers. White mothers showed lowest body dissatisfaction -White reported higher levels of restrained eating than Asian -White daughters showed higher concern over the calorie content of food than others -Possibility of different level of identification between ethnicity and age	-Small sample size -Wide age range -Mixed nationalities of Asian -Impact of TV on acculturation and body image not tested

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Haudek, C. et al. (1999)	-Asian American (n = 25; mean age 18.8) -Caucasian (n = 26; mean age 18.8) Female undergraduates	-Selection of samples on the basis of screening questions -Scores above 7 in screening questions invited to the study -Eating Disorders Examination (EDE) -Interviews -Questionnaires: 1) Demographic and Weight History Questionnaire 2) Drive for thinness, bulimia, and body dissatisfaction subscales of the EDI 3) Parental Bonding Instruments (PBI) 4) Suinn-Lew Acculturation Scale (SL-ASIA) 5) 20-item self-report questionnaire to assess acculturation.	-Asian Americans reported more shape concern than Caucasians -No ethnic difference on eating, restraint or weight concerns -Asian Americans reported higher scores on body dissatisfaction and drive for thinness sub-scales of the EDI -Acculturation not associated with level of eating disturbance -Perception of low maternal care associated with high level eating problems	-Poor reliability of self-reporting -Small sample size -No detail of screening test -Appropriateness of interview in the study -Uncertainty of generalisability -Appropriateness of PBI to population already past adolescence -True relationship between factors not certain

Appendix Five. Cross-ethnic Body Image Studies (Cross-sectional)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Fitzgibbon, M. L. et al. (2000)	Whites (n = 63) Black (n = 231) Hispanic (n = 95; 40% Puerto Rican, 20% Mexican, and 40% from Central America) All females	-Demographic data from questionnaire -The Body Mass Index -The Figure Rating Scale (FRS) -The Short Acculturation Scale (SAS)	Whites experienced body discrepancy at a lower BMI level and below the criterion of the overweight Black and Hispanics did not report the body discrepancy until they became overweight Hispanic tend to increase in body discrepancy at smaller increases in the BMI	-Use of BMI values only -A large difference in sample sizes between groups
Pope Jr., et al. (2000)	Austria (n = 54) France (n = 65) The United States (n = 81) All males	-Anthropometry -The Somatomorphic Matrix (SM)	Men chose a ideal body that is muscular than their current body	-Validity of the SM has not been confirmed

Appendix Six. Cross-ethnic Body Image study (Longitudinal study)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Huenemann, R. L. et al. (1966)	Approximately 1,000 teenagers 10% Oriental 30% Negro 60% Caucasian Both genders	-Longitudinal from 9th grade through to 12th grade -Measurement of 11 circumferences -Body composition determined by UWW, helium displacement in Siri's chamber, and K measurement in the whole body counter -Questionnaire consist of: 1) their views on food, 2) activity, and 3) body size and shape	-Grade differences in results -Influence of race on meal preferences -No association between sex, race, body composition, and socio-economic status with diet ratings -Dissatisfaction with weight, fatness/leanness, stature and certain body dimensions is predominant attitude among teenagers -The number of girls described themselves as fat increased as they grew older -More Orientals and Caucasians expressed themselves as fat than Negro counterpart	-No detailed anthropometry data -Large difference in sample size -May not be generalized as subjects recruited from one school

Appendix Six. Cross-ethnic Body Image study (Longitudinal study)

Researchers (Year)	Sample characteristics	Methods	Results	Limitations
Furukawa, T. (1994)	Japanese (Males = 42, Females = 102) High school students Enrolled in a 1-year placement with a host family Countries: North America (66%), South America (5%), Europe (25%), and Asia (4%)	-Longitudinal study -Conduct questionnaires during the pre-departure orientation -MPI to measure personality traits. -General Health Questionnaire (GHQ-30) -Parental Bonding Instrument (PBI) -People in Your Life Scale (PIYL) -Eating Disorders Inventory (EDI) Japanese version. -6 months later GHQ-30 and social integration section of PIYL were mailed to the students. -After the return to Japan, administered Maudsley Personality Inventory (MPI), GHQ-30, and EDI	-Students gained body weight -Substantial minority manifested maladaptive eating patterns -Neuroticism and introversion correlated with high drive for thinness during the stay Parental overprotection, lack of interoceptive awareness, and interpersonal distrust predicted bulimic behaviours -No change in body dissatisfaction subscale.	-No age detail -Not specifically focused on body image but more on eating behaviour change -Small sample size for males -Reliance of self-reporting -No detail with specific environmental influences -No control groups

Appendix Seven. Details of anthropometry results obtained from the study groups

Appendix Seven. Details of anthropometry results obtained from the study groups

	JA (n =145) ± SD	JJ (n =88) ± SD	AA (n =143) ± SD
Age (Years)	23.3 ± 4.0	20.5 ± 1.6*	22.3 ± 4.0**
Stature (cm)	171.5 ± 5.3	172.9 ± 5.3	180.9 ± 7.9*, **
Body mass (kg)	64.2 ± 8.8	64.1 ± 8.9	77.2 ± 11.4*, **
Triceps (mm)	9.7 ± 3.6	9.9 ± 4.2	10.4 ± 4.6
Subscapular (mm)	11.1 ± 4.8	11.1 ± 4.8	11.5 ± 5.8
Biceps (mm)	4.2 ± 1.5	4.4 ± 1.8	4.7 ± 1.9
Iliac crest (mm)	12.6 ± 6.9	13.0 ± 7.0	14.4 ± 8.0
Supraspinale (mm)	8.5 ± 5.1	9.3 ± 6.0	10.2 ± 6.3
Abdominal (mm)	13.6 ± 7.5	13.1 ± 7.9	18.6 ± 10.6*, **
Front thigh (mm)	11.3 ± 6.2	11.5 ± 5.3	13.8 ± 6.6*, **
Medial calf (mm)	7.4 ± 3.2	7.9 ± 4.2	9.5 ± 4.7*, **
Arm (relaxed) (cm)	28.7 ± 2.8	28.2 ± 2.9	31.5 ± 3.1*, **
Arm (flexed and tensed) (cm)	30.2 ± 2.8	29.7 ± 2.7	33.3 ± 3.0*, **
Waist (cm)	74.5 ± 5.9	73.1 ± 6.2	81.0 ± 7.4*, **
Gluteal (cm)	92.4 ± 5.1	92.0 ± 5.4	99.4 ± 6.5*, **
Calf (maximum) (cm)	36.4 ± 2.5	36.4 ± 2.8	37.7 ± 2.7*, **
Biacromial bone breadth (cm)	39.5 ± 1.8	40.1 ± 1.4	40.4 ± 2.1*, **
Biiliocristal bone breadth (cm)	27.4 ± 1.5	27.5 ± 1.3	28.8 ± 1.8*, **
Humerus (cm)	6.7 ± 0.3	6.7 ± 0.4	7.3 ± 0.4*, **
Femur (cm)	9.8 ± 0.5	9.8 ± 0.5	10.0 ± 0.8*, **

* Significant differences with Japanese living in Australia at the 0.05 level.

** Significant differences with Japanese living in Japan at the 0.05 level.

Appendix Eight. Follow-up results of the lifestyle questions

Appendix Eight. Follow-up results of the lifestyle questions

Questions	Responses	JJ (n=60) (%)	AA (n=47) (%)
Demographic questions			
Marital status	Married	1.2	5.6
	Never married	98.8	94.4
Occupation *	Student	98.3	55.3
	Worker	1.7	40.4
	Other	4.3	0.0
Person (s) living with *	Alone	46.7	6.4
	Family	50.0	38.3
	Long-term partner	0.0	8.5
	Spouse/Share mate	3.4	46.8
Hours of sleep *	5 hours or less	15.0	0.0
	6-7 hours	65.0	55.4
	8-9 hours	18.4	44.6
	10 hours or more	1.7	0.0
Eating habit questions			
Eat three meals a day *	Yes	65.0	87.2
	No	35.0	12.8
Frequency of missing breakfast *	Eat everyday	51.7	87.2
	Miss 2-3 days/week	16.7	8.5
	Miss 4-5 days/week	5.0	2.1
	Do not eat almost always	26.7	2.1
Aware of content of food *	Yes	31.7	74.5
	No	68.3	25.5
Type of diet *	No specific diet	96.7	74.5
	Vegetarian	0.0	2.1
	Weight reduction	0.0	4.3
	Fat modified	1,7	0.0
	Other	1.7	19.1

* Significant ethnic difference at the 0.05 level.

No significant differences were observed between the assessments for both study groups.

Appendix Eight. Follow-up results of the lifestyle questions

Questions	Responses	JJ (n=60) (%)	AA (n=47) (%)
Physical activity questions			
Hours involved in strenuous exercise (per week)	None 0.5-3 hours 4-10 hours 11-30 hours 31 hours or more	23.3 51.7 16.7 6.7 1.7	10.6 55.4 27.6 6.4 0.0
Hours involved in vigorous exercise (per week) *	None 0.5-3 hours 4-10 hours 11-30 hours 31 hours or more	40.0 50.0 5.0 3.4 1.7	17.0 55.3 19.2 4.3 4.3
Hours involved in moderate exercise (per week)	None 0.5-3 hours 4-10 hours 11-30 hours 31 hours or more	18.3 45.0 26.7 6.6 3.3	8.5 44.7 31.9 14.9 0.0
Frequency of vigorous exercise (per week) *	Never 1-3 times 4-6 times 7 or more times	13.3 66.7 16.7 3.3	4.3 55.3 34.0 6.4

* Significant ethnic difference at the 0.05 level.

No significant differences were observed between the assessments for both study groups.

Appendix Eight. Follow-up results of the lifestyle questions

Nutrient intakes results from the four-days dietary record

Nutrients	JJ (n =58) ± SD	AA (n =45) ± SD
Total energy (kJ) *	9256.5 ± 2831.0	10368.2 ± 2190.3
Protein (g) *	77.9 ± 27.7	103.6 ± 28.3
Total fat (g) *	67.1 ± 22.6	88.2 ± 28.5
Carbohydrate (g) ##	301.9 ± 102.3	294.8 ± 70.0
Cholesterol (mg) #	365.7 ± 132.5	333.4 ± 203.2
Calcium (g) *	558.9 ± 314.7	1094.3 ± 376.4
Iron (g) *	8.7 ± 4.0	12.7 ± 3.9
Zinc (g) *	9.7 ± 3.3	12.7 ± 3.9
Dietary fibre (g) *	11.1 ± 6.8	26.0 ± 10.3
Vitamin A equivalent (µg)	707.8 ± 723.9	1017.7 ± 939.1
Thiamin (mg) *	1.13 ± 0.45	2.06 ± 0.90
Riboflavin (mg) *	1.50 ± 0.58	2.49 ± 1.11
Niacin equivalent (mg) *	17.6 ± 6.2	47.2 ± 13.5
Vitamin C (mg) *, ##	74.8 ± 49.6	126.0 ± 80.6
Total folate (µg) *	276.0 ± 168.1	355.1 ± 154.8
Energy contribution from		
Protein (%)*	14.3 ± 2.1	17.3 ± 4.7
Carbohydrate (%)*, ##	52.2 ± 5.5	45.6 ± 5.9
Fat (%)*	27.0 ± 5.3	31.1 ± 5.7
Energy contribution from		
Monounsaturated fat (%) *, #	9.0 ± 2.2	11.3 ± 2.9
Polyunsaturated fat (%)*, ##	5.4 ± 1.6	4.5 ± 1.5
Saturated fat (%)*	7.6 ± 2.2	12.5 ± 3.3

* Significant ethnic difference at the 0.05 level.

Significant differences between assessments for the JJ group at the 0.05 level.

Significant differences between assessments for the AA group at the 0.05 level.

Appendix Nine. Public presentations

Publications:

- Kagawa, M., Kerr, D., and Binns, C. (2003) Ethnic differences in the BMI-%BF relationships between young Japanese and Australian-Caucasian males living in Australia using dual-energy x-ray absorptiometry *Asia-Pacific Journal of Public Health* 15, S27-S32.

Oral presentations:

- The 35th Asia Pacific Academic Consortium of Schools of Public Health (APACPH) conference (20-23 October 2003, Shanghai, China)
Ethnic differences in the BMI-%BF relationship: A comparative study of Japanese and Australian Caucasian males by Kagawa, M., Kerr, D., Uchida, H., and Binns, C.

- 2004 Pre-Olympic Congress (6-11 August 2004, Thessaloniki/Hellas, Greece)
Body image and body composition differences in Japanese and Australian males by Kagawa, M, Kerr, D, Dhaliwal, S, and Binns, C

Poster presentations:

- 2002 Australian Conference of Sports and Medicine in Sport (12-16 October 2002, Melbourne, Australia)
Validation of the Somatomorphic Matrix Computer Program for predicting body composition in Japanese and Australian Caucasian Males by Kagawa, M., Kerr, D., and Binns, C.

- 2004 Pre-Olympic Congress (6-11 August 2004, Thessaloniki/Hellas, Greece)
The prediction of body fat in Japanese males living in Australia by Kagawa, M., Kerr, D., Dhaliwal, S., and Binns, C.

Appendix Ten. The research questionnaires

Ethnic and Cultural Influence on Body Image among males

INVESIGATOR: Masaharu Kagawa 9305-4996 OR 0419-857-908

Name: ____

DOB: _____________

Subject ID ________________

Address: ____

____

_________________________ **P/C**_______________

Telephone: ____________________ **(H)** _______________________ **(W)**

Mobile: __________________________

E-mail: ____

Available time to call: ____

1. Nationality: _______________________________

2. Ethnic background: **Caucasian** **Asian** **Hispanic** **Black**
(Circle one)

3. Do you have any chronic health problems? (eg. Asthma, High blood pressure, Cardiac disease, Diabetes) **Yes/No**
(Circle one)

If Yes, please write a detail below.
Detail:____

____

______

4. Are you currently taking any medication for above chronic health problems? **Yes/No**
(Circle one)

Appendix Ten. The research questionnaires

Test Date (d/m/year)________________ **ID# (A, J, JA)**
Re-test Date (d/m/year)______________

Please circle a number representing answer or write down in a space provided.

Office Use

What is your Date of Birth? ______/_______/19_____

What is your sex?
1. Male

2. Female

What is your current martial status?
1. Married
2. Divorced
3. Widowed
4. Never Married

Where were you born?
1. Japan
2. Australia/New Zealand
3. USA
4. Europe
5. South America
6. Africa
7. Asia other than Japan _______________
8. Other ___________________

About how long have you lived in this country?
____Years, or ______Months, or _______Weeks, or _______Days

What is your nationality?

____

What is your first language spoken at home? _____________________

Appendix Ten. The research questionnaires

What is your ethnic or racial background?
1. White or Caucasian
2. Japanese
3. Black or African-American
4. Aboriginal/Torres-Strait Islanders
5. Asians other than Japanese: Please specify _______________
6. Other ___________________

What is your mother's ethnic or racial background?
1. White or Caucasian
2. Japanese
3. Black or African-American
4. Aboriginal/Torres-Strait Islanders
5. Asians other than Japanese: Please specify _______________
6. Other ___________________

What is your father's ethnic or racial background?
1. White or Caucasian
2. Japanese
3. Black or African-American
4. Aboriginal/Torres-Strait Islanders
5. Asians other than Japanese: Please specify _______________
6. Other ___________________

What is your current occupation?
1. University student: Course_____________________
2. Language school student
3. TAFE student: Course_______________________
4. Full-time worker
5. Working holiday (Working only)
6. Other___________________

Right now, are you living with:
1. Your spouse
2. Long-term partner or lover
3. Roommate
4. Host family
5. Family (other than spouse)
6. Alone

Appendix Ten. The research questionnaires

Right now, are you living in a:
1. Private room or apartment
2. House of host family
3. Communal facility or group home including youth hostel
4. Hospital
5. No fixed living arrangement

Do you usually eat 3 meals a day?
1. Yes
2. No

Do you usually eat a breakfast?
1. Eat almost everyday
2. Miss 2-3 days a week
3. Miss 4-5 days a week
4. Do not eat almost always

Are you aware with an amount and/or content of meals you eat?
1. Yes
2. No

Which one of the following best describes your usual way of eating?
1. No special way of eating
2. Vegetarian
3. Weight reduction diet
4. Diabetic diet
5. Fat modified diet to lower blood fat (cholesterol)
6. Other ___________________________________

How often do you compare your body size, shape, and fatness with people in the media?
1. Always
2. Sometimes
3. Occasionally
4. Seldom

How often do you compare your body size, shape, and fatness with people in the media who are different ethnic backgrounds with your own?
1. Always
2. Sometimes
3. Occasionally
4. Seldom

Appendix Ten. The research questionnaires

Do you compare your body shape with different ethnic group on the street?
1. Always
2. Sometimes
3. Occasionally
4. Seldom

What do you think of yourself in terms of weight in comparison with same ethnic, gender, and age group?
1. Light
2. Slightly light
3. About right weight
4. Slightly overweight
5. Overweight
6. I don't know

What do you think of yourself in terms of amount of total body fat in comparison with same ethnic, gender, and age group?
1. Very small amount
2. Small amount
3. About right
4. Large amount
5. Very large amount
6. I don't know

How much do you think your current weight is? _____________kg

How much do you think your current height is? _____________cm

By your height, what is your ideal weight? ________________kg

Are you currently trying to reach or to maintain your ideal weight?
1. Yes
2. No

On the average, during past 4 weeks, how many hours <u>IN A DAY</u> did you sleep? (include naps)
1. 5 hours or less
2. 6 hours
3. 7 hours
4. 8 hours
5. 9 hours
6. 10 hours or more

Appendix Ten. The research questionnaires

On the average, during past 4 weeks, how many hours IN A WEEK did you spend in the following activities?

	Never	½ to 1 hr.	2-3 hrs.	4-6 hrs.	7-10 hrs.	11-20 hrs.	21-30 hrs.	≥ 31 hrs.
Strenuous sports (such as jogging, bicycling on hills, tennis, racquetball, swimming laps, aerobics)								
Vigorous work (such as moving heavy furniture, shoveling, weight lifting, loading/ unloading trucks, or equivalent manual labor)								
Moderate activity (such as housework, golfing, bowling, bicycling on level ground, gardening)								

On the average, during past 4 weeks, how many TIMES A WEEK did you take part in vigorous physical activity (Strenuous sport or work) long enough to work up a sweat?

1. Never
2. 1 time
3. 2 times
4. 3 times
5. 4 times
6. 5 times
7. 6 times
8. 7 times or more

Please apply (X) under the column which applies best to each of the numbered statements.
All of the results will be *strictly* confidential. Most of questions directly relate to food or eating, although other types of questions have been included. Please answer each question carefully. Thank you.

	Always	Very Often	Often	Sometimes	Rarely	Never
1. Am terrified about being overweight						
2. Avoid eating when I am hungry						
3. Find myself preoccupied with food						
4. Have gone on eating binges where I feel that I my not be able to stop						
5. Cut my food into small pieces						
6. Aware of the calorie content of food that I eat						
7. Particularly avoid foods with high carbohydrate content						
8. Feel that others would prefer if I ate more						
9. Vomit after I have eaten						
10.Feel extremely guilty after eating						
11. Am preoccupied with a desire to be thinner						
12. Think about burning up calories when I exercise						
13. Other people think that I am too thin						
14. Am preoccupied with the thought of having fat on my body						
15. Take longer than others to eat meals						
16. Avoid foods with sugar in them						
17.Eat diet foods						
18. Feel that food controls my life						
19. Display self-control around food						

	Always	Very Often	Often	Sometimes	Rarely	Never
20. Feel that others pressure me to eat						
21. Give too much time and thought to food						
22. Feel uncomfortable after eating sweets						
23. Engage in dieting behaviour						
24. Like my stomach to be empty						
25. Enjoy trying new rich foods						
26. Have the impulse to vomit after meals						

Appendix Ten. The research questionnaires

This questionnaire contains a number of statements. Please read each one and tick the box that shows how much you agree or disagree with the statement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I usually feel physically active.					
2. I prefer not to let other people see my body.					
3. People hardly ever find me sexually attractive.					
4. I get so worried about my shape that I feel I ought to diet.					
5. I feel fat when I can't get clothes over my hips.					
6. People avoid me because of my looks.					
7. I feel satisfied with my face.					
8. I worry that other people can see rolls of fat around my waist and stomach.					
9. I think I deserve the attention of the opposite sex.					
10. I hardly ever feel fat.					
11. There are more important things in life than the shape of my body.					
12. I think it is ridiculous to have plastic surgery to improve your looks.					
13. I like to weigh myself regularly.					
14. I feel fat when I wear clothes that are tight around my waist.					
15. I have considered suicide because of the way I look to others.					
16. I quickly get exhausted if I overdo it.					
17. I have a slim waist.					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
18. My life is being ruined because of the way I look.					
19. Wearing loose clothing makes me feel thin.					
20. I hardly ever think about the shape of my body.					
21. I feel that my body has been mutilated.					
22. I am proud of my physical strength.					
23. I feel that I have fat thighs.					
24. I couldn't join in with games or exercise because of my shape.					
25. Eating sweets, cakes or other high calorie food, makes me feel fat.					
26. I have a strong body.					
27. I think my buttocks are too large.					
28. I feel fat when I have my photo taken.					
29. I try and keep fit.					
30. Thinking about the shape of my body stops me from concentrating.					
31. I spend too much time thinking about food.					
32. I am preoccupied with the desire to be lighter.					
33. If I catch sight of myself in a mirror or shop window it makes me feel bad about my shape.					
34. People laugh at me because of the way I look.					
35. I often feel fat.					
36. I spend a lot of time thinking about my weight.					
37. I am a bit of an "iron-man".					
38. I feel fat when I am lonely.					

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
39. I worry that my thighs and bottom look dimply.					
40. People often compliment me on my looks.					
41. Losing one kilogram in weight would not really affect my feelings about myself.					
42. I feel fat when I can no longer get into clothes that used to fit me.					
43. I have never been very strong.					
44. I try to avoid clothes which make me especially aware of my shape.					

Please mark the degree to which you agree with each of the following statements. All of your responses will be strictly confidential, so please be honest.

	Definitely Disagree				Definitely Agree
I place a great deal of importance on my body shape	(a)	(b)	(c)	(d)	(e)
I buy products that promise to give me a better body	(a)	(b)	(c)	(d)	(e)
I am not self-conscious about my body shape	(a)	(b)	(c)	(d)	(e)
I am always trying to improve my body shape	(a)	(b)	(c)	(d)	(e)
I wear clothes that highlight the best aspects of my body and hide the worst aspect of my body	(a)	(b)	(c)	(d)	(e)
It really bothers me when I can't keep my body in shape	(a)	(b)	(c)	(d)	(e)
I'm very attentive to my body shape	(a)	(b)	(c)	(d)	(e)

Appendix Ten. The research questionnaires

Questions asked by the Somatomorphic Matrix (SM) computer program.

Demographic questions

What is your first name?

How old are you?

What is your ethnic background?

Caucasian

Black

Asian

Hispanic

Where do you live?

What is your sexual orientation?

Heterosexual

Homosexual

Bisexual

No preference and/or do not wish to respond

How satisfied are you, on a scale from 1-5, with the way your body looks? (5 is very satisfied)

How fat, on a scale from 1-5, do you feel? (5 is very fat)

On average, how many hours per week do you exercise?

What type of exercise do you do? (None, Aerobic, Weightlifting, Some of each)

Aerobic exercises includes activities like running, biking, or basketball)

Have you ever gone on a diet to (lose weight, gain weight)?

Have you ever been diagnosed with an eating disorder, like anorexia or bulimia? (Yes, No, Do not know)

Have you ever taken any type of pill or supplement to help you lose or gain weight? (Yes, No, Do not know)

If yes, what were they?

Appendix Ten. The research questionnaires

Body image questions

Questions used in the validation study:

Please choose the image which most closely resembles your own body.

Please choose the image that represents the body that you ideally would like to have.

Please choose the image that represents the body of an average person of your age.

Please choose the image that represents the body women desire most.

Please choose the image that represents the body men desire most.

Questions used in the main study:

Please choose the image which most closely resembles your own body.

Please choose the image that represents lower most "acceptable" body shape before you define the image to be "too thin".

Please choose the image that represents upper most "acceptable" body shape before you define the image to be "too fat".

Please choose the image that represents the body women desire most.

Please choose the image that represents the body men desire most.