UNIVERSITI PUTRA MALAYSIA

FACTORS THAT CONTRIBUTE TO THE PERCENTAGE OF BODY FAT AMONG MALAYSIAN ADOLESCENTS

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of Requirement for the Degree of Master of Science

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UPM

DEDICATION

With love I dedicate this thesis to

All the boys and girls who participated in this project

For their participation, co-operation, and commitment in making this project a success.

Ang's family and John Yap

For their invaluable encouragement and emotional support that provided me the strength and courage from the beginning until the completion of this thesis.

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March 2003

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Faculty: **Medicine and Health Sciences**

Obesity or excess body fat in adolescents has become an increasing clinical and public health concern worldwide. In adolescents, body fat accumulation is a complex interaction of dietary, physical activity, genetic, environment and social factor. This study aims to determine the factors that contribute to the percentage of body fat among Malaysian adolescents.

A non-experimental cross sectional study was carried out among Form One and Two secondary students (11 to 15 years old) in Kedah and Pulau Pinang. Respondents were selected from a three-staged stratified random sampling from schools that fulfilled the inclusion criteria of co-educational, multiracial composition, non-religious and non-residential.

Of the 6555 respondents (screening), the prevalence of underweight, normal weight and overweight was 11.3%, 70.9% and 17.7% respectively. While underweight prevalence was higher among the rural adolescents, prevalence of overweight was higher among the urban adolescents. Body Mass Index measurements (n = 769) was found to be a good measure of percentage of body fat (sensitivity and specificity).

Female adolescents had significantly higher percentage of body fat (χ^2 = 4.491; $p < 0.05$) than male adolescents. The mean monthly household income was significantly higher among the male adolescents with high percentage of body fat compared to those with optimum percentage of body fat ($t = -2.237$; $p < 0.05$).

Comparison of diet quality between female adolescents with optimum and high percentage of body fat indicated significantly higher mean calorie ($t = -2.474$; $p < 0.05$), protein ($t = -2.128$; $p < 0.05$), fat ($t = -2.466$; $p < 0.05$), iron ($t = -2.057$; $p < 0.05$), thiamine ($t = -2.071$; $p < 0.05$) and niacin ($t = -2.307$; $p < 0.05$) intakes for adolescents with high percentage of body fat. Both male and female adolescents with high percentage of body fat had significantly higher basal metabolic rate and total energy expenditure. Negative energy balance was obtained for both male and female adolescents with high percentage of body fat.

Predictors of percentage of body fat for male adolescents are basal metabolic rate, age and ethnicity (R^2 = 71.7). As for female adolescents, predictors of percentage of body fat are basal metabolic rate and age (R^2 = 81.1). For male adolescents, having higher basal metabolic rate, being younger and being a non-Chinese contributed to having higher percentage of body fat. Younger female adolescents with higher basal metabolic rate were reported to have higher percentage of body fat.

The findings of the present study provide an insight into factors that contribute to body fatness among Malaysian adolescents. However, a longitudinal study is needed to identify the pattern of changes in body fatness and consequently determine factors that contribute to obesity among the adolescents.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

FAKTOR-FAKTOR YANG MEMPENGARUHI PERATUS LEMAK TUBUH DI KALANGAN REMAJA DI MALAYSIA

Oleh

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Di serata dunia, obesiti atau keadaan lemak tubuh berlebihan di kalangan remaja semakin mendapat perhatian dari segi kesihatan klinikal dan umum. Di kalangan remaja, pengumpulan lemak tubuh adalah suatu interaksi yang kompleks di antara faktor-faktor pemakanan, aktiviti fizikal, genetik, persekitaran dan sosial. Kajian ini bertujuan untuk menentukan faktor-faktor yang mempengaruhi peratus lemak tubuh di kalangan remaja di Malaysia.

Satu kajian rentas bukan eksperimen telah dijalankan di Kedah dan Pulau Pinang di kalangan pelajar-pelajar sekolah menengah Tingkatan Satu dan Dua (berumur 11 hingga 15 tahun). Responden dipilih melalui persampelan rawak tiga peringkat di antara sekolah-sekolah yang memenuhi kriteria-kriteria berikut; campuran lelaki dan perempuan, berbilang bangsa, bukan sekolah agama dan bukan sekolah berasrama.

Daripada 6555 responden (*screening*), prevalens kekurangan, normal dan berlebihan berat badan adalah 11.3%, 70.9% dan 17.7% masing-masing. Prevalens kekurangan berat badan adalah lebih tinggi di kalangan remaja dari kawasan luar bandar, manakala prevalens berlebihan berat badan adalah lebih tinggi di kalangan remaja

dari kawasan bandar. Pengukuran Indeks Jisim Tubuh (n = 769) adalah suatu cara pengukuran yang baik bagi peratus lemak tubuh (sensitiviti dan spesifisiti).

Remaja perempuan mempunyai peratus lemak tubuh yang lebih tinggi secara signifikan berbanding dengan remaja lelaki ($\chi^2 = 4.491$; $p < 0.05$). Purata pendapatan keluarga di kalangan remaja lelaki yang mempunyai peratus lemak tubuh yang tinggi adalah lebih tinggi secara signifikan berbanding dengan remaja lelaki yang mempunyai peratus lemak tubuh yang optimum ($t = -2.237$; $p < 0.05$).

Perbandingan kualiti pemakanan di antara remaja perempuan yang mempunyai peratus lemak tubuh yang tinggi dan optimum menunjukkan bahawa purata pengambilan kalori ($t = -2.474$; $p < 0.05$), protein ($t = -2.128$; $p < 0.05$), lemak ($t = -2.466$; $p < 0.05$), zat besi ($t = -2.057$; $p < 0.05$), tiamin ($t = -2.071$; $p < 0.05$) dan niasin ($t = -2.307$; $p < 0.05$) adalah lebih tinggi secara signifikan bagi mereka yang mempunyai lemak tubuh yang tinggi. Kedua-dua remaja lelaki dan perempuan yang mempunyai lemak tubuh yang tinggi mempunyai kadar metabolik asas yang lebih tinggi secara signikan. Keseimbangan tenaga yang negatif telah diperolehi bagi kedua-dua remaja perempuan dan lelaki yang mempunyai lemak tubuh yang berlebihan.

Faktor-faktor yang meramal peratus lemak tubuh remaja lelaki adalah kadar metabolik asas, umur dan etnik ($R^2 = 71.7$). Bagi remaja perempuan pula, faktor-faktor yang meramal peratus lemak tubuh adalah kadar metabolik asas dan umur ($R^2 = 81.1$). Bagi remaja lelaki, kadar metabolik asas yang lebih tinggi, umur yang lebih muda dan dari kalangan bukan Cina dikaitkan dengan peratus lemak tubuh yang

lebih tinggi. Remaja perempuan yang lebih muda dengan kadar metabolik asas yang lebih tinggi dilaporkan mempunyai peratus lemak tubuh yang lebih tinggi.

Keputusan daripada kajian ini memberi pengertian terhadap faktor-faktor yang mempengaruhi peratus lemak tubuh di kalangan remaja di Malaysia. Walau bagaimanapun, kajian jangka panjang adalah diperlukan untuk mengenal pasti corak perubahan kegemukan tubuh dan seterusnya menentukan faktor-faktor yang mempengaruhi obesiti di kalangan remaja.

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GLOSSARY OF TERMS

1. ***Adolescence*** is a significant period of human growth and maturation where occurrence of unique changes (hormonal, cognitive and emotional changes) and establishment of many adult patterns (increase in body dimensions – somatic growth, development of secondary sexual characteristics, menarche and spermache) take place (WHO, 1995).

2. ***Adolescent*** is an individual between the ages of 10 to 24 years old which includes both definitions considered by WHO in its 1986 publication as "adolescents" (10-19 years) and those defined as "youth" (15-24 years) by United Nations (WHO, 1995). This research will only take into account individuals between the age of 11 to 15 years old.

3. ***Body fat*** is the adipose or fatty tissue of the body (Miller and Frank, 1992). It can refer to either the percentage of body weight that is fat (%BF) or the absolute amount in kilogram (kg) of total body fat (TBF) (Roche *et al.,* 1981).

4. ***Body fatness*** is a compositional description of body fat. It is a general term used to state the situation of having body fat (Norgan, 1991). Body fatness is measured by the amount of body fat that an individual has (percentage of body fat) (Slaughter *et al.,* 1988, Weststrate and Deurenberg, 1989 and Rush *et al.,* 1997).

5. ***Obesity*** is an excess of body fat or an excessive accumulation of fat in the body (Weil, 1990 and Miller and Frank, 1992).

4. ***Overweight*** is an excess of body weight according to the normal range of weight chart derived form a reference population (Weil, 1990). In this study, adolescents with BMI that exceeds the 85th percentile of the NCHS/WHO reference data (by age and gender) are considered overweight (WHO, 1995).

7. ***Normal weight*** is a situation of adolescents with BMI between 5th percentile and 85th percentile of the NCHS/WHO reference data (by age and gender) (WHO, 1995).

8. ***Underweight*** is a situation of adolescents with BMI that is lower than the 5th percentile of the NCHS/WHO reference data (by age and gender) (WHO, 1995).

9. ***Low percentage of body fat (%BF)*** is where %BF $\leq$ 10.0 for male and $\leq$ 15.0 for female.

10. ***Optimum %BF*** is where %BF between 10.01 and 19.99 for male and between 15.01 and 24.99 for female.

11. ***High %BF*** is where %BF $\geq$ 20.0 for male and $\geq$ 25.0 for female.

CHAPTER ONE

INTRODUCTION

While body fat is defined as the adipose or fatty tissue of the body (Miller and Frank, 1992), body fatness is a compositional description of body (Norgan, 1991). Both body fatness and body fat share the same unit of measurement and it is indicated either as the percentage of body fat or the absolute amount in kilogram (kg) of total body fat (TBF) (Roche, Siervogel, Chumlea and Webb, 1981). In many studies, the most common measurement used to indicate body fatness is the percentage of body fat (Slaughter, Lohman, Boileau, Horswill, Stillman, Van Loan and Bemben, 1988, Weststrate and Deurenberg, 1989 and Rush, Plank, Laulu and Robinson, 1997).

Body fatness has frequently been used interchangeably with obesity and overweight. Body fatness does not share the same definition as obesity and overweight (Norgan, 1991). The grading of body fatness relates to the concept of obesity and leanness (Roche *et al.*, 1981). Obesity is the condition of having excess body fat (Roche *et al.* 1981) while leanness is defined as the condition in which there is very little body fat (Weil, 1990 and Miller and Frank, 1992). Overweight, another term mistakenly used to replace body fatness is defined as an excess of body weight according to the normal range of weight chart derived from a reference population. An overweight person with no excess of body fat is not and should not be categorized as obese. Although obesity and overweight may correlate with each

other, each describes different bodily characteristics, and almost certainly has different prevalences, etiologies and outcomes (Weil, 1990).

Adolescence is a phase of life cycle in which dramatic social, physical and biological changes occur. Physical changes of the body such as increases in height and weight, deposition and redistribution of fat and increased lean body mass create special nutritional needs for adolescents (Spear, 2000). An awareness of the characteristics and needs of this special group, can contribute to a greater appreciation for adolescents in general and for those who have special nutritional needs (Worthington-Roberts and Rees, 1996). Apart from that, evidence from longitudinal studies indicates that overweight and excessive body fatness during adolescence, may predict elevated health risks and increased adult mortality (Booth, Macaskill, Lazarus and Baur, 1999, Dietz, 1997, Must, 1996, Must, Jacques, Dallal, Bajema and Dietz 1992 and Nieto, Szklo and Comstock, 1992).

Problem Statement

Obesity or excess body fat in adolescents has become an increasing clinical and public health concern worldwide. In the United States, there appears to be a secular trend toward increasing obesity among children (Dietz, 1991,Daniels and Khoury, 1997 and Popkin and Udry, 1998) and in recent years, research in countries such as Brazil, United States and Canada have shown that children of all ages are fatter than they were years ago (Sawaya, Dallal, Solymos, de Sousa, Ventura, Roberts and Sigulem, 1995, Popkin and Udry, 1998 and O'Loughlin,

Paradis, Meshefedjian and Gray-Donald, 2000). This trend of increased obesity and body fatness appears to result in increased morbidity in childhood and may result in premature mortality in adulthood (Daniels and Khoury, 1997).

The trend observed in the developed countries is also seen in the Asian countries. Rapid advancements in the socio-economic situation in many Asian countries including Malaysia have resulted in significant life-styles changes of the population. As a consequence of rapid socio-economic development and increased affluence, significant proportions of the affluent segments of the population are now known to be afflicted with various non-communicable diseases associated with overnutrition, namely obesity, hypertension, coronary heart disease and cancer (Tee, 1995). The prevalence of obesity in Malaysia appears to be higher than the levels in other Asian countries such as Thailand, China and Japan (Khor, 1997).

Obesity in Malaysia is no longer an urban problem but has extended to rural communities. A study carried out among the rural communities in Malaysia reported an increase in the prevalence of pre-obese and obese rural Malay adults over the past decades (Khor, Azmi, Tee, Kandiah and Huang, 1999). Adults in rural communities reported 18.3% of males and 32.4% of females being overweight and another 5.2% of males and 13.6% of females were obese. The findings serve to exemplify that mild to moderate form of obesity have reached alarming proportions in rural adult populations (Ng, Tee and Azriman, 1995). In a study carried out among the Standard One and Standard Six students in Selangor, comparison of prevalence rates between schools in urban and rural areas show a higher proportion of obesity among the urban school children. However, the prevalence rate of 6.1% among rural

school children should serve as an early warning signal of the seriousness of obesity among children in rural communities (Bong and Safurah, 1996).

Currently, body mass index is used worldwide as an indicator of body fatness and obesity in adolescence because of the relative easiness and accuracy of the basic measurements (Himes and Dietz, 1994). In Malaysia, body mass index has always been used as a simple anthropometric index that reflects obesity and the body fat content of Malaysian adults (Ismail, 1995, Ismail, Zawiah, Chee and Ng and 1995, Ng *et al.*, 1995) and adolescents (Woon, 1995 and Kasmini, Idris, Fatimah, Hanafiah, Iran and Asmah Bee, 1997). A study carried out on adults in rural Sarawak has found body mass index to be correlated with skinfold measurements (Ulijaszek and Strickland, 1996). Even though body mass index has a high correlation with body fatness, it does not measure body fat directly (National Task Force on the Prevention and Treatment of Obesity, 2000). On the other hand, skinfold measurements are better body fatness indicator because it provides a direct measure of body fat (Willett, 1998). Skinfold measurements have even been used as the gold standard for the basis of comparison with other body fatness measure (Kraemer, Berkowtitz and Hammer, 1990).

Body fat accumulation in adolescence is a complex interaction of many factors such as dietary, physical activity, genetic, environment and social factors (and their interactions) (Katzmarzyk, Pérusse, Malina and Bouchard, 1999 and Kretchmer, 1988). Studies carried out in Malaysia on body fatness among adolescents are somewhat limited and thus far, no study addressing the factors that contribute to body fatness among adolescents has been carried out. Furthermore, the limited