



THE THIRD
NATIONAL HEALTH AND MORBIDITY SURVEY
2006
(NHMS III)

NUTRITIONAL STATUS

INSTITUTE FOR PUBLIC HEALTH
NATIONAL INSTITUTES OF HEALTH
MINISTRY OF HEALTH
MALAYSIA
2008



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JANUARY 2008**

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THE THIRD NATIONAL HEALTH AND MORBIDITY SURVEY 2006 (NHMS III)

NUTRITIONAL STATUS

Chapter I: Nutritional Status of Children (Aged below 18 Years)

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NUTRITIONAL STATUS

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MESSAGE FROM THE DIRECTOR GENERAL OF HEALTH MALAYSIA

Since independence, Malaysia has achieved remarkable progress economically and socially, notably in the health sector, through a well planned and comprehensive health care delivery system. However, Malaysia's health care system still has to grapple with many challenges, particularly the rising costs of health care and the increasing demands and expectations for quality care by our consumers. In this respect, the Ministry of Health formed the 'National Institutes of Health' to spearhead health research that will provide the body of evidence to help formulate health policies and create new tools to measure health impacts arising from the series of interventions made in the provision of health care. This will lead to an environment of better governance.

The first National Health & Morbidity Survey (NHMS) was conducted in 1986 by the Institute for Public Health (IPH) which is currently one of the research organizations under the umbrella of the National Institutes of Health (NIH). IPH was also given the task of conducting the second NHMS II in 1996 and the current NHMS III in 2006. Data and information gathered by these surveys are consistently and extensively been used by the Ministry of Health in formulating the Malaysian Health Plans and evaluating the intervention programmes.

The publication of the current NHMS III report would generate much interest amongst of all health care stakeholders in the country as well as international health organizations. It is my sincere wish that the data and information generated by NHMS III be fully distributed, discussed and utilized to enhance further the provision of health care in this country. The data generated on the national health and health-related prevalence would be useful in assessing the national health burden as well as allowing for international comparison of health systems achievements.

I would like to take this opportunity to congratulate all those directly involved in the conduct of the survey, namely members of the National Steering Committee, the Advisory Committee, Research Groups and the Working Committee for their untiring efforts in the planning and conduct of the survey as well as publication of the reports. I would like to specially place on record the Ministry's appreciation of the excellent work done by the Principal Investigator and his team and for their dedication and tenacious efforts in spearheading this project to fruition. The Ministry of Health is committed to conduct these National Health and Morbidity Surveys on a regular basis and hope that IPH will continue to provide the leadership in conducting future National Health and Morbidity Surveys in this country.

Thank you.



Tan Sri Datuk Dr Hj. Mohd Ismail Merican
Director General of Health, Malaysia.

MESSAGE FROM THE DEPUTY DIRECTOR GENERAL OF HEALTH (RESEARCH AND TECHNICAL SUPPORT)

The Research and Technical Support Programme of the Ministry of Health emphasizes the need for research in supporting decision making and planning the activities in the Ministry. Only then can we ensure that every decision made either in planning resources or providing services to the people is supported by evidence based information and ensuring better results and outcome. We would certainly prefer local expertise rather than depend on foreign experts to carry out local research.

Under the umbrella of the National Institutes of Health, the Institute for Public Health has actively been involved in conducting research in public health and the National Health and Morbidity Survey is one of the major research conducted by IKU. This is the third time IKU has been given the responsibility to conduct such a mammoth task. I am very pleased that a lot of improvement have been made in the way this survey was conducted based on the experience learnt during the first and second surveys. However, due to the nature of the community survey, not all diseases and health issues were able to be covered in this survey. The research teams had to conduct an extensive literature reviews for relevant and up to date information on the health status of the Malaysian population.

I believe that the information in these reports are extremely valuable to all decision makers at the National State and district levels as well as those interested in the health of the Malaysian population. It can be a tool in providing guidance in developing and implementing strategies for the disease prevention and control programme in Malaysia.

I would like to take this opportunity to congratulate the research team members who have successfully undertaken and completed this survey. I would also like to thank all individuals and agencies who directly or indirectly made the completion of this survey possible.

The Institute for Public Health again gained a feather in its cap by successfully completing the Third National Health and Morbidity Survey.



**Datuk Ir. Dr. M. S. Pillay,
Deputy Director General of Health (Research and Technical Support).**

MESSAGE FROM THE DIRECTOR OF INSTITUTE FOR PUBLIC HEALTH

This is the third time the Institute for Public Health (IPH) was given the task to conduct the National Health and Morbidity Survey. The frequency of the study is every 10 years and I am proud that the Institute is able to conduct the surveys successfully since it was first initiated in 1986.

I would like to take this opportunity to thank the Director-General of Health Malaysia, Tan Sri Datuk Dr. Hj. Mohd Ismail Merican, and the Deputy-Director General of Health (Research and Technical Support), Datuk Ir Dr.M.S. Pillay, whose invaluable support and guidance were instrumental in the successful completion of the third National Health and Morbidity Survey (NHMS III). Our appreciations are also extended to all members of the Steering Committee and the Advisory Committee of NHMS III.

I would like also to take this opportunity to congratulate the Principal Investigator and his Project Team Members in completing the NHMS III study and the publication of its report. The NHMS III was made possible through the collaboration of all agencies. The meetings, workshops and conferences that were organised, met their intended objectives and the hard work put up by the field staffs, ensured the three months data collection productive and successful.

My sincere gratitude also goes to Dr.Nirmal Singh, the former Director of the Institute for Public Health, Chairman of the Advisory Committee for his continuous support and guidance which contributed towards the successful completion of the study.

I hope the documentation of this report will be beneficial for future reference.

Finally, I would like to thank all those involved in the survey for a job well done, in making the NHMS III a success and finally producing the national report of this survey.



Dr. Yahya Baba,
Director, Institute for Public Health.

MESSAGE FROM THE PRINCIPAL INVESTIGATOR NHMS III

It is indeed a challenging task when the responsibility was given to me to conduct this survey. I learned the hard way and gained a lot of valuable experience in leading the survey. The survey also taught me lots of new techniques and how it should be addressed which is not available in the textbook. In doing so, I also learned the meaning of friendship and honesty, how to manage people involved and manage properly the given budget.

I would like to take this golden opportunity to thank the Director General of Health Malaysia, Tan Sri Datuk Dr. Hj. Mohd Ismail Merican, Chairman of the Steering Committee for giving me the confidence, valuable support and guidance for the success of this survey.

I would also like to thank the Deputy Director General of Health Malaysia (Research & Technical Support), Datuk Ir. Dr. M.S. Pillay as Co-chairman of the Steering Committee for his patience in seeing through the survey until its completion the production of the national report.

My sincere appreciation to current Director of Institute for Public Health (IPH), Dr. Yahya Baba and former Directors of IPH, Dr. Nirmal Singh, Dr. Sivashamugam and Dr. Sulaiman Che Rus for their trust in me to carried out this survey. Their support for the survey has resulted the smooth conduct and success of the survey.

Special thanks to all State Directors, State Liaison Officers, Field supervisors, Scouts, Data Collection Team members for their full cooperation and efforts to ensure the success of the data collection. My appreciation is also extended to the Assistant Principal Investigator, Dr. Mohd Azahadi Omar, Main Research Group members, members of the Working Committee, Data Management group members, Statistics Consultant, Research group members, Research Officers and Research Assistants for their patience and tolerance of my behaviour to ensure the success of the study. Nevertheless I acknowledge a lot more can be done in strengthening the study.

I believe this report will serve as a useful reference for future surveys and helps in improving the local data sources and also add new valuable information for the Ministry of Health to use in the planning process. I also would like to encourage all research members to participate in further analysis of the data and publish the findings in peer review journals.

Thanks to everyone.



**Dr. Hj. Ahmad Faudzi Hj. Yusoff,
Principal Investigator, The Third National Health and Morbidity Survey,
Institute for Public Health.**

*D*EDICATION

The Nutritional Status Research Group dedicates this Report to all the respondents who participated in the Third National Health and Morbidity Survey, 2006. This study would not have been possible without their good cooperation.

*A*UTHORS' STATEMENT

This volume has been produced by the authors through working together as a team with dedication and commitment over the past several months.

Throughout the process of preparing this report, the group has also collaborated and communicated closely with all the Health Programme Managers, particularly in the analysis and interpretation of data.

Findings in this volume have not been adjusted for differences in population composition of the survey sample and the 2006 population in Malaysia.

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Last but not least, our sincere appreciation goes to all the respondents for their cooperation in participating in this survey.

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ABBREVIATIONS

BMI	Body Mass Index
CC	Calf Circumference
CI	95% Confidence Interval
HAZ	Height for Age Z score
IDF	International Diabetes Foundation
LQ	Living Quarters
MANS	The Malaysian Adults Nutrition Survey
MyNCDS-1	Malaysian Non-communicable Disease Surveillance 1
MOH	Ministry of Health Malaysia
NHANES	National Health and Nutrition Examination Survey, USA
NHMS I	The First National Health and Morbidity Survey (1986)
NHMS II	The Second National Health and Morbidity Survey (1996)
NHMS III	The Third National Health and Morbidity Survey (2006)
NPAN I	The First National Plan of Action for Nutrition (1996 - 2000)
NPAN II	The Second National Plan of Action (2006-2015)
UNICEF	United Nations Children's Fund
WAZ	Weight for Age Z score
WC	Waist Circumference
WHO	World Health Organization
WHZ	Weight for Height Z score
WP	<i>Wilayah Persekutuan</i> or Federal Territory

CHAPTER I



**NUTRITIONAL STATUS OF CHILDREN
(AGED BELOW 18 YEARS OLD)**

ABSTRACT

Children are a vulnerable group in that their growth and development can be impaired by multiple factors, especially inadequate food intake and infections. Thus, the health and nutritional status of children reflect in part the socio-economic development and health care services of a country.

The Third National Health and Morbidity Survey, 2006 (NHMS III) includes assessment of the nutritional status of children (aged 0 to below 18 years) in a nationally representative sample. The children were assessed using weight and stature (length or height) measurements. Data for a total of 22,032 eligible children was analysed using the NutStat (CDC 2000) software. The nutritional status of the children was classified according to z scores for weight for age (WAZ), height for age (HAZ) and height for age WHZ as recommended by WHO (1995). Weight for age was determined among 21,249 children, while height for age was obtained for 21,078 children. In addition weight for height was determined among 12,526 children aged 0 – 13 years using the same software.

The survey found 81.4% (CI: 80.8 - 82.0) of the children with normal weight for age (WAZ \geq -2SD to $<$ +2SD), 80.5% (CI: 79.7 - 81.2) with normal height for age (HAZ \geq -2SD to $<$ +2SD), and 81.6% (CI: 80.8 - 82.3) having normal weight for height (WHZ \geq -2SD to $<$ +2SD). The national prevalence of underweight children (WAZ $<$ -2SD) was 13.2% (CI: 12.6 - 13.9), the level being higher in boys 14.5% (CI: 13.7 - 15.3) compared to girls at 12.0% (CI: 11.3 - 12.7). The prevalence of underweight was higher among children in rural areas at 16.0% (CI: 15.1 - 17.1) compared to that in urban areas at 11.4% (CI: 10.7 - 12.2).

In contrast, 5.4% (CI: 5.0 - 5.7) of the children was found to be overweight (WAZ $>$ +2SD), with a slightly higher prevalence among boys at 6.0% (CI: 5.6 - 6.5) than girls at 4.7% (CI: 4.35 - 5.1). The proportion of overweight children was higher in urban areas at 6.3% (CI: 5.8 - 6.8) than in rural areas at 4.0% (CI: 3.5 - 4.5).

The prevalence of stunting (HAZ $<$ -2SD) was found in 15.8% (CI: 15.1 - 16.6) of the children, with a slightly higher prevalence among boys [16.6% (CI: 15.7 - 17.6)] than girls [15.0% (CI: 14.2 - 15.9)]. The prevalence of stunting in rural areas was higher at 19.4% (CI: 18.2 - 20.6) compared to 13.6% (CI: 12.7 - 14.5) in urban areas. Meanwhile, the prevalence of wasting (WHZ $<$ -2SD) was found in 10.4% (CI: 9.8 - 11.1) of the children, with a slightly higher prevalence among boys [10.6% (CI: 9.8 - 11.5)] than girls [10.2% (CI: 9.4 - 11.1)]. The prevalence of wasting was quite similar in urban and rural areas at 11.0% (CI: 10.2 - 11.9) and 9.5% (CI: 8.7 - 10.5) respectively.

In conclusion, the majority of Malaysian children were found to have satisfactory nutritional status. Nonetheless, underweight and stunting prevalence prevailed being higher among children in rural areas than their urban counterparts. On the other hand, the prevalence of overweight was higher in urban children compared to those in rural areas. These findings on the manifestation of the double burden of malnutrition in different strata indicate the need for appropriate public health promotion and socioeconomic improvement interventions, towards further improving the nutritional well-being of the children, in line with the objectives of the National Nutrition Policy of Malaysia.

1. INTRODUCTION

Malaysia has undergone rapid pace of socioeconomic development since attaining independence in 1957. Concomitant with industrialization and urbanization during this period, there have been changes in the food supply leading to increased availability of a vast variety of imported and domestically produced food. Accordingly, the lifestyles of Malaysians in general have also changed with respect to eating habits, food preferences as well as physical activity patterns.

Typical of a country in nutrition transition, Malaysia bears the double burden of malnutrition. This is manifested in the form of under-nutrition as exemplified by underweight and stunting in children, especially in low-income households, while the problem of overweight and obesity is growing especially in the adult population (Tee 1999; NCCFN 2006). Micronutrient deficiency particularly iron deficiency and to a lesser extent, iodine deficiency disorders, vitamin A deficiency and folate deficiency also affect the vulnerable groups namely, young children, women of childbearing age and the elderly.

Against this backdrop, the National Nutrition Policy was formulated to address the country's nutritional challenges toward enhancing the health and nutritional well being of the people (MOH 2005). This Policy was developed as a follow-up of the First National Plan of Action for Nutrition (NPAN I) for the period of 1996-2000. The main thrust of NPAN I was aimed at supporting strategies for combating the burden of nutritional deficiencies and diet-related chronic diseases. The strategies of NPAN I was expanded and reinforced in the current NPAN II (2006-2015) through the following thrust areas:

- Improving breastfeeding and complementary feeding practices
- Improving food intake and dietary practices
- Reducing protein–energy malnutrition
- Reducing micronutrient deficiency
- Reducing overweight and obesity
- Preventing and controlling diet related non-communicable diseases

The thrust on reducing protein-energy malnutrition in the NPAN II focused on the reduction of the prevalence of underweight among children below 5 years, from 10.6% in 2003 to 5% by 2015. Meanwhile a similar target for children aged 6 to 18 years is at reducing the prevalence of underweight by 25% over the same period. Thus, data on the nutritional status of these age groups are needed for monitoring and evaluation of the NPAN II targets.

Through the NMHS III, important data on the nutritional status of Malaysians of all age groups were obtained. Such data were not reported in the previous two NHMS. This report focuses on the nutritional status of children aged between 0 to below 18 years.

2. LITERATURE REVIEW

Nutritional status is an important determinant of the health of the population. In assessing nutritional status, anthropometry is one of the key tools used. It comprises several types of body measurements including weight and stature, which are the most common measurements used to assess the nutritional status of children. Based on these measurements, the anthropometric indices of weight for age, height for age and weight for height are computed to classify the nutritional status of children.

2.1 Underweight and Stunting

There are few nationally representative data on the nutritional status of children in Malaysia. In 1998-2000, the Ministry of Health with the cooperation of UNICEF carried out a national nutritional status assessment of children below 6 years. The survey involving 5,108 children found 19.2% underweight and 16.7% stunted (MOH 2000). According to the surveillance data of the Ministry of Health, the overall prevalence of underweight among children below five years was 17.3% in 2004 compared to 25% in 1990.

In the 1990s, a research project on the nutritional status of low-income households in estates, padi farming, fishing, coconut- and rubber-smallholding communities in Peninsular Malaysia was undertaken. In these nationally representative samples, the prevalence of underweight and stunting among 4,779 children aged 18 years and below was 29.8% for boys and 25.5% for girls (Khor & Tee 1998). The prevalence of stunted children in these rural communities was 31.1% and 26.9% in the boys and girls respectively. By age groups, the prevalence of underweight was lowest among the infants and highest among children aged above 1 to 6 years. By type of community, the prevalence of under-nutrition was generally higher in the fishing and rubber-smallholding groups than the other groups.

As for children in urban areas, Moy et al. (2004) determined the nutritional status of 3,556 school children aged 11 to 16 years in Kuala Lumpur, and found 16.2% and 13.3% of the boys and girls respectively were underweight (< 5th percentile of the BMI-for-age). Indian children had the highest underweight prevalence for both sexes compared to the Malay and Chinese children. In general, the prevalence of under-nourished children is relatively lower in urban areas compared to rural areas.

In comparison, the prevalence of underweight and stunting among children in developing countries in the region appear relatively high. The 6th National Nutrition Survey of the Philippines conducted in 2003 reported underweight prevalence of 28.1% and 27.2% in girls and boys aged 0-5 years respectively (FNRI 2005). Stunting was found in 29.7% and 31.1% respectively in Filipino girls and boys aged below 6 years. The Indonesia Socioeconomic Household Surveys between 1992 and 1999 reported that the overall prevalence of underweight among children less than five years was 28.5% in 1999 having decreased from 37.7% in 1992 (Waters et al. 2004). In Vietnam, while underweight reduction has taken place quite rapidly dropping from 51.5% in 1985 to 44.5% in 1995, the level remains high at 33.1% in 2000 (Hop et al. 2003).

2.2 Overweight and Obesity

Obesity in childhood predisposes the child to the risk of non-communicable diseases such as cardiovascular disease, hypertension and diabetes mellitus in adulthood. Obesity in childhood is

associated with high consumption of energy-dense foods, unhealthy snacks and beverages coupled with reduced physical activity and increased sedentary lifestyle. Reflecting the concern for the growing problem of overweight in adults, there are increasingly more studies on overweight and obesity in Malaysian children.

In a study involving 6,239 children aged 7-16 years attending schools in Kuala Lumpur, Kasmini et al. (1997) found the prevalence of overweight was 3.5%, with the boys showing slightly higher prevalence (4.3%) than the girls (2.7%). In the study by Moy et al. (2004) involving similar age groups attending schools in Kuala Lumpur, overweight prevalence (\geq 95th percentile of the BMI-for-age) of 7.3% was found, with no significant differences between the sexes and ethnicity groups.

Bong & Safurah (1996) assessed 1,275 primary one and primary six children in urban schools in Selangor and found overweight in 9.8% of these children. They also recorded overweight prevalence of 6.1% among 1,431 children of similar age groups from rural schools in Selangor. In contrast, the study on low-income households from rural communities found only 2% of the children below 18 years were overweight (Khor & Tee 1998).

Overweight in young children is a growing problem in developed and developing countries. The Singapore School Health (2000) reported overweight prevalence of 14.7% in children aged 12-13 years and 13.1% among those aged 15-16 years. Overweight prevalence of 10.8% was found among Thai children aged 7-9 years in urban Khon Kaen (Langendijk et al. 2003). Data from the China national surveys on the health in school children showed that the prevalence of overweight and obesity in children aged 7-18 years increased 28 times and obesity increased four times between 1985 and 2000, a trend that was particularly marked in boys (Wu 2006). The proportion of overweight in this age group was less than 2% in 1985 but rose to 17% for boys and 10% for girls by the year 2000.

Another facet of the malnutrition burden is the co-existence of under-nutrition and obesity in the same household. The manifestation of this type of double burden of malnutrition has increasingly been reported. Such findings were recorded in Brazil, Russia and China (Doak et al. 2000), and similar findings have also been documented in Malaysia, the Philippines and Indonesia, (Khor & Zalilah 2003; Angeles-Agdeppa et al. 2003; Kolsuwat et al. 2006). In these Southeast Asian countries, the double burden of malnutrition was found in low-income households, manifesting often as overweight mother and underweight preschool-age child pairs. Thus, nutrition interventions especially in poor communities face the challenge of having to address simultaneously the twin problems of underweight and obesity that affect members of the same household. As the double burden of malnutrition has serious implications on human development, including deleterious effects on growth and development of children, it is thus imperative to obtain up-to-date data on the nutritional status of different age groups to enable appropriate interventions be undertaken.

3. OBJECTIVES

3.1 General Objective

To determine the nutritional status of Malaysian children aged between 0 to below 18 years using anthropometric indicators.

3.2 Specific Objective

To determine the nutritional status of children aged between 0 to below 18 years using weight and stature (height/length) measurements.

4. METHODOLOGY

In calculating the sample size, stratification and sampling design, advice was sought from the Methodology Division Department of Statistics Malaysia as well as from several other biostatistics consultants.

4.1 Sampling Design and Sample Size

4.1.1 Sampling frame

The sampling frame for this survey was updated until 2004; an effort undertaken prior to the implementation of Labour Force Survey (LFS) 2004. In general, each selected Enumeration Blocks (EB) comprised of 8 sampled Living Quarters (LQ). The EBs were geographically contiguous areas of land with identifiable boundaries. Each contains about 80-120 LQs with about 600 persons. Generally, all EBs are formed within gazetted boundaries.

The EBs in the sampling frame were also classified by urban and rural areas. The classification into these strata was made up in terms of population of gazetted and built-up areas as follows:

Stratum	Population of gazetted areas and built-up
Metropolitan	75,000 and above
Urban Large	10,000 to 74,999
Urban Small	1,000 to 9,999
Rural	The rest of the country

For sampling purposes, the above broad classification was found to be adequate for all states in Peninsular Malaysia and the Federal Territories of Kuala Lumpur and Labuan. However, for Sabah and Sarawak, due to problems of accessibility, the rural stratum had to be further sub-stratified based on the time taken to reach the area from the nearest urban centre.

For the purpose of urban and rural analysis, Metropolitan and Urban Large strata are combined together thus referred to as 'urban' stratum, while for Urban Small and the various sub-divisions of the rural areas they are combined together to form a 'rural' stratum.

4.1.2 Sample size

The sample size was determined based on 95% Confidence Interval (CI) and the following factors:

a) Expected prevalence rate

The prevalence rate of the health problems for Malaysia obtained from the National Health and Morbidity Survey 2 (NHMS2) were used to estimate the overall sample size. Using the previous finding of 10% prevalence rate, the initial sample size at the state level was calculated in order to come up with overall sample size. The size was further apportioned for each state using the probability proportionate to size (PPS) method.

b) Response rate of the NHMS II

The response rates, which ranged from 83 to 97% for the NHMS2 of each state, were taken into consideration in the course of the determination of sample size.

c) Margin of error and design effect

As the factors of precision and efficient of the survey are paramount, the decision reached for the targeted margin of error is 1.2 and the design effect valued at 2. These values were used at the initial stage of the calculation of the sample size of each state.

The survey findings answering to the specific objectives of this survey are expected to be used for state level programmed planning. Thus, the calculation for the sample size has taken into consideration that the data is to be analyzed at the state level.

In addition to the major factors mentioned earlier, the availability of resources, namely, financial and human resources, and the time taken to conduct this survey also become part of the process of the determination of sample size.

4.1.3 Sample design

A two stage stratified sampling design with proportionate allocation was adopted in this survey. The first stage sampling unit was the EB and within each sampled EB, the LQs were selected as second stage unit.

4.2 Method of Data Collection

4.2.1 Questionnaire

A bi-lingual (Bahasa Malaysia and English) pre-coded questionnaire was designed, pre-tested and piloted prior to the survey.

Overall, the-face-to-face interview (FI) questionnaire was administered to all members of each household. The questionnaire consisted of separate booklets to cater for different age groups of

<2, 2-<13, 13-<18 and \geq 18 years old. For those aged below 13 years, the child's parent or guardian responded on the child's behalf. Those aged 13 years and above were required to answer the respective questionnaires themselves.

Certain terminology and items in the questionnaire were also made available in the dialects or languages of the main ethnic groups in Malaysia, such as Hokkien and Cantonese for the Chinese and Tamil for the Indians. The local dialects of Sabah and Sarawak were also considered. These pronunciations were recorded on tape with an accompanying 'romanised' version of the script. To ensure the accuracy of the translation, all versions were back translated into English by independent reviewers.

4.2.2 The interview

A trained non medical or paramedical interviewer conducted the interview. All qualified adult members from the selected LQs were interviewed face-to-face by trained personnel. Parents or guardians were expected to provide information for their children aged 12 years and below (primary school).

Interviews were commenced from late morning until late evening for each 5-day week. Where an interview was unsuccessful due to the absence of the respondent at the selected LQ, repeated visits were conducted. A household member was only classified as a non-respondent if 3 visits were unsuccessful.

4.3 Field Preparations and Logistic Support

A number of state liaison officers were recruited in preparation for the survey proper. Strong networking with state liaison officers and District Health Officers (MOH and local authorities) from the areas sampled for the survey was established. Field scouts were mobilized from these areas to identify and tag the LQ's selected for the survey, as well as informed to the community and related government agencies of the importance and schedule of the planned survey. State liaison officers were also assisting Field Supervisors in the arrangement of transportation, accommodation and other logistics for the survey teams.

4.3.1 Pilot study

A pilot study was conducted on a sample of EB's (not included in the NHMS III) about 2 months prior to the actual nationwide survey. It was conducted in three different areas in and around the Klang Valley, namely Sepang, Klang and Bangsar. The population in these locations comprised of three distinct socio-demographic strata that are rural, semi-urban and urban respectively. The pilot study focused on the following aspects of the survey:

- a) Testing of the questionnaire
- b) Testing of the field logistic preparation
- c) Testing of the scouting activities
- d) Testing of the central monitoring and logistic support

4.3.2 Training of data collection teams

A training period of 2 weeks for field supervisors, team leaders, nurses and interviewers were held to familiarize them with the questionnaire, developed their interpersonal communication skills and appreciate the need for a good teamwork. Briefing on the questionnaire, mock interview in the classroom and individual practice under supervision was conducted during the training.

4.4 Quality Control

Quality control procedures for field data collection were done in two stages, at the field and central levels.

4.5 Data Management

4.5.1 Data screening

The following data screening exercises had been conducted at field and central levels prior to data entry:

- a) Field data screening by each interviewer at the end of his/her interview
- b) Field data screening of each question by peer interviewers through exchanging questionnaire booklets
- c) Field data screening by team leaders and field supervisors
- d) Central data screening of the questionnaire variables by the quality control team.

4.5.2 Data entry

The data entry system was developed to record the information collected during the data collection phase. It is a web based system that allows multiple simultaneous accesses to the database. The NHMS III used a double manual data entry method and any discrepancy between both entries was verified by the supervisors. The data entry started simultaneously with data collection (first week of April 2006) and was completed at the end of January 2007. The data entered was stored in the database according to the module. The databases were designed using Structured Query Language (SQL) which is a standard language for relational database management system.

4.5.3 Data Analysis

Preliminary analysis was carried out on cleaned sample data sets to enhance quality control and refinement of the computer analysis programmes. Upon completion of data entry and cleaning, full analysis were carried out. The analysis was carried out towards computing expected outcomes of each research topic.

Analysis of the data was conducted using STATA and SPSS 15.0. All analyses took into account the complex survey design and unequal selections of NHMS III. Findings are reported as the weighted estimates of the prevalence (mean value, confidence interval and standard error of the mean). Prior to analysis, the data was examined for quality. Appendix 4 presents the quality report for data on the children.

4.6 Anthropometric Measurements

Anthropometric measurements namely, body weight and stature were taken of the eligible children. Stature was taken as standing height for children aged 2 years and above, who were able to stand upright independently or with assistance. As for children who were less than 2 years old, his/her recumbent length was measured instead. Assistants were trained to carry out these measurements based on a standard procedure in the Technical Manual of the NHMS III. For details of the procedures for these measurements, please refer to the Technical Manual of Anthropometric Measurements. Body weight, standing height and recumbent length measurements were carried out according to the protocol of the World Health Organization (WHO, 1995).

Body weight for children aged 2 years and above was measured in light indoor clothings without shoes, using a Tanita digital lithium weighing scale (Tanita 318, Japan) to the nearest 0.1 kilogram. For children below 2 years, weight was measured by means of a Tanita digital weighing scale (Tanita 1583, Japan) to the nearest 0.01 kilogram. The standing height of the children was measured without shoes using a SECA portable body meter (SECA 206, Germany) to the nearest 0.1 centimeter. A SECA measuring mat (SECA 210, Germany) was used to measure the recumbent length to the nearest 0.1 centimeter. A non-stretchable measuring tape was pasted on the right side of the measuring mat to facilitate reading of the length. All measurements were taken twice and the average value was used for data entry (Appendix 1: Table 1).

A study on the reliability and validity of all the anthropometric measurements was done prior to the survey in order to determine the precision of the instruments and measurements (Appendix 3).

Based on the weight and height measurements, anthropometric indices namely, weight for age, height for age and weight for height were computed using the NutStat (CDC 2000) software. This software contains a database for children aged 0 to 18 years with respect to weight for age and height for age. However, for weight for height, the database covered ages 0 to 13 years only. Hence, the result reported below for weight for height is limited to children aged 0 to 13 years only. Nutritional status was defined according to z scores for weight for age (WAZ), height for age (HAZ) and weight for height (WHZ) as shown in Appendix 1: Table 2.

5. FINDINGS

Data for a total of 22,032 eligible children was analysed using the NutStat (CDC 2000) software. Weight for age was determined among 21,249 children, while height for age was obtained for 21,078 children. In addition, weight for height was determined among 12,526 children aged 0 – 13 years using the same software. The prevalence of normal nutritional status, underweight, overweight, stunting and wasting are shown in Appendix 1 (Table 3 to Table 5). In addition, the variability of the measured parameters are shown in Appendix 2 (Figure 1 to Figure 20).

5.1 Prevalence of Children with Normal Nutritional Status

Overall, the survey found 81.4% (CI: 80.8 - 82.0) of the children with normal weight for age and 80.5% (CI: 79.7 - 81.2) had normal height for age. Data on the prevalence of children with normal nutritional status by these indicators are presented in Appendix 1 (Table 3 & Table 4), in accordance with demographic and socio-economic characteristics.

As for prevalence data on weight for height, this report presents the prevalence for wasting only, as the data is available for children aged 0 to 13 years only, owing to the limitation of the database itself, as explained previously.

5.1.1 Prevalence by state

The state of Pulau Pinang had the highest prevalence of children with normal weight for age [85.1% (CI: 82.0 - 87.7)] followed by Kedah [83.5% (CI: 81.2 - 85.6)]. All the other states showed normal weight for age prevalence that exceeded 75%, with Perlis showing the lowest prevalence [75.6% (CI: 69.1 - 81.1)] followed by Perak [79.7% (CI: 77.2 - 82.0)].

Negeri Sembilan showed the highest prevalence of children with normal height for age at 86.9% (CI: 83.9 - 89.4) followed by Pulau Pinang [86.3% (CI: 83.3 - 88.8)]. Meanwhile, Sabah had the lowest prevalence for normal height for age at 70.0% (CI: 67.5 - 72.3) followed by Johor [79.1% (CI: 76.9 - 81.1)].

5.1.2 Prevalence by urban-rural strata

Urban areas showed a higher prevalence of children with normal weight for age [82.3% (CI: 81.5 - 83.1)] and height for age [81.9% (CI: 80.9 - 82.9)] than rural areas [80.0% (CI: 79.0 - 81.0)] and [78.2% (CI: 77.0 - 79.4)] respectively.

5.1.3 Prevalence by gender

The survey found a higher prevalence of girls with normal weight for age [83.4% (CI: 82.5 - 84.1)] compared to the boys [79.5% (CI: 78.6 - 80.4)]. There is also a higher prevalence of girls with normal height for age [81.4% (CI: 80.5 - 82.3)] than the boys [79.6% (CI: 78.5 - 80.5)].

5.1.4 Prevalence by ethnicity

Chinese children had the highest prevalence of normal weight for age [87.8% (CI: 86.5 - 89.0)], followed by Indian [81.4% (CI: 79.2 - 83.4)] and Malay children [80.7% (CI: 79.9 - 81.5)]. Other Bumis and Others groups showed lower prevalence of normal weight for age at 77.9% (CI: 75.8 - 79.8) and 77.2% (CI: 72.3 - 81.5) respectively.

Similarly, for the prevalence of children with normal height for age, Chinese showed the highest level at 87.4% (CI: 86.0 - 88.7), followed by Indians at 84.9% (CI: 82.6 - 87.0), Malays [80.5% (CI: 80.0 - 81.4)], Other Bumis [71.7% (CI: 69.3 - 74.0)] and Others groups [70.1% (CI: 65.3 - 74.5)].

5.1.5 Prevalence by age

The prevalence of children with normal weight for age was highest among infants [88.8% (CI: 86.7 - 90.6)] and lowest in the 1-3 years age group [77.0% (CI: 75.5 - 78.5)]. The latter age group was also found to have the lowest prevalence for normal height for age [74.0% (CI: 72.3 - 75.6)]. The highest prevalence for normal height for age was among the age group of 14-15 years [86.0% (CI: 84.5 - 87.5)].

5.1.6 Prevalence by household monthly income

Prevalence exceeding 80% of children with normal weight for age was found for households earning more than RM1000 per month. A similar finding was obtained for the prevalence of normal health for age by household income. The lowest prevalence for normal weight for age [75.2% (CI: 72.5 - 77.7)] and height for age [73.0% (CI: 69.8 - 76.0)] was in households earning less than RM400 per month.

5.2 Prevalence of Underweight

The national prevalence of underweight children was 13.2% (CI: 12.6 - 13.9). Data on the prevalence of underweight according to demographic and socio-economic characteristics are shown in Appendix 1 (Table 3).

5.2.1 Prevalence by state

Sabah and Perlis had the highest prevalence of underweight children at 19.1% (CI: 17.0 - 21.5) and 19.0% (CI: 13.4 - 26.3) respectively. In contrast, WP Kuala Lumpur had the lowest prevalence of underweight at 8.1% (CI: 6.3 - 10.4) followed by Pulau Pinang [9.0% (CI: 6.8 - 11.7)].

5.2.2 Prevalence by urban-rural strata

Rural areas had a higher prevalence of underweight children [16.0% (CI: 15.1-17.1)] compared to urban areas [11.4% (CI: 10.7 - 12.2)].

5.2.3 Prevalence by gender

Prevalence of underweight was lower among girls than boys at [12.0% (CI: 11.3 - 12.7)] and [14.5% (CI: 13.7 - 15.3)] respectively.

5.2.4 Prevalence by ethnicity

According to ethnicity, the Chinese showed the lowest prevalence of underweight at 5.2% (CI: 4.4 - 6.1) followed by Indians [10.5% (CI: 8.8 - 12.5)] and Malays [14.3% (CI: 13.6 - 15.0)]. The Others group had the highest prevalence of underweight at 18.9% (CI: 14.7 - 23.9) followed by Other Bumis [18.4% (CI: 16.6 - 20.5)].

5.2.5 Prevalence by age

Infants showed the lowest prevalence of underweight at 7.1% (CI: 5.7 - 8.9), while the highest prevalence was among children aged 1-3 years at 19.8% (CI: 18.4 - 21.3).

5.2.6 Prevalence by household monthly income level

In general, prevalence of underweight decrease as household monthly income increases. The highest prevalence of underweight was among households earning less than RM400 monthly at 21.4% (CI: 18.9 - 24.2), while the income category of RM4000-RM5000 per month showed the lowest prevalence of underweight at 6.8% (CI: 5.0 - 9.1).

5.3 Prevalence of Overweight

The national prevalence of overweight children was found to be 5.4% (CI: 5.0 - 5.7). The findings for the prevalence of overweight children according to demographic and socio-economic characteristics are shown in Appendix 1 (Table 3).

5.3.1 Prevalence by state

The WP Kuala Lumpur had the highest prevalence of overweight children at 9.1% (CI: 7.2 - 11.4) followed by Melaka [7.2% (CI: 4.5 - 11.1)] and Negeri Sembilan [7.1% (CI: 5.1 - 9.8)]. Meanwhile Sabah and Kelantan had the lowest prevalence at 2.3% (CI: 1.7 - 3.0) and 2.9% (CI: 2.2 - 3.9) respectively.

5.3.2 Prevalence by urban-rural strata

There was a higher prevalence of overweight children in urban areas [6.3% (CI: 5.8 - 6.8)] compared to rural areas [4.0% (CI: 3.5 - 4.5)].

5.3.3 Prevalence by gender

Prevalence of overweight was higher in boys [6.0% (CI: 5.6 - 6.5)] than girls [4.7% (CI: 4.3 - 5.1)].

5.3.4 Prevalence by ethnicity

Among the ethnic groups, Indian children had the highest prevalence of overweight [8.1% (CI: 6.7 - 9.8)], followed by Chinese [7.1% (CI: 6.1 - 8.1)] and Malays [5.0% (CI: 4.6 - 5.5)].

5.3.5 Prevalence by age

The lowest prevalence of overweight was among children aged 1-3 years at 4.1% (CI: 3.1 - 5.5). Children aged 7-9 years showed the highest overweight prevalence [6.8% (CI: 6.0 - 7.7)] followed by ages 4-6 years [6.4% (CI: 5.6 - 7.3)].

5.3.6 Prevalence by household monthly income

In general, the prevalence of overweight tends to increase with increasing household income. While the lowest prevalence of overweight was in the monthly income category of RM400 - <RM700 [3.0% (CI: 2.4 - 3.8)], the highest overweight prevalence was in the category earning more than RM5000 per month [9.2% (CI: 7.7 - 11.1)].

5.4 Prevalence of Stunting

The national prevalence of stunting among the children was 15.8% (CI: 15.1 - 16.6). The findings for the prevalence of stunting by demographic and socio-economic characteristics are shown in Appendix 1 (Table 4).

5.4.1 Prevalence by state

Sabah had the highest prevalence of stunting at 26.9% (CI: 24.6 - 29.4), followed by Kelantan [18.6% (CI: 16.0 - 21.7)]. The state with the lowest stunting prevalence was Pulau Pinang at 9.8% (CI: 7.4 - 12.9) followed by Negeri Sembilan at 10.6% (CI: 8.4 - 13.5).

5.4.2 Prevalence by urban-rural strata

Stunting was found higher in the rural areas at 19.4% (CI: 18.2 - 20.6) compared to the urban areas [13.5% (CI: 12.7 - 14.5)].

5.4.3 Prevalence by gender

Prevalence of stunting was slightly higher among boys [16.6% (CI: 15.7 - 17.5)] than girls [15.0% (CI: 14.2 - 15.9)].

5.4.4 Prevalence by ethnicity

Among the ethnic groups, children in the Other Bumis group had the highest prevalence of stunting at 25.1% (CI: 22.8 - 27.5) followed by the Others group at 23.9% (CI: 19.6 - 28.7). The lowest prevalence of stunting was seen among Chinese children [7.7% (CI: 6.7 - 8.8)] followed by Indian [8.7% (CI: 7.1 - 10.5)] and Malay [16.5% (CI: 15.7 - 17.4)] children.

5.4.5 Prevalence by age

The prevalence of stunting was highest among children aged 16 - <18 years [23.7% (CI: 21.7 - 25.8)]. The age groups of 1-3 years and 4-6 years also ranked high for stunting prevalence at 17.2% (CI: 15.9 - 18.7) and 16.70% (CI: 15.4 - 18.1) respectively. Meanwhile infants showed the lowest prevalence of stunting at 9.0% (CI: 7.4 - 11.1).

5.4.6 Prevalence by household monthly income

Generally stunting prevalence decreases with monthly household income. Households with income less than RM400 per month had the highest prevalence of stunting [24.2% (CI: 21.2 - 27.4)], while households with monthly income of RM4000 - <RM5000 had the lowest prevalence of 8.9% (CI: 6.7 - 11.8).

5.5 Prevalence of Wasting

It should be noted that the data for this section covers children aged 0 to 13 years only as previously explained. The national prevalence of wasting was 10.4% (CI: 9.8 - 11.1). The findings for the prevalence of wasting according to demographic and socio-economic characteristics are shown in Appendix 1 (Table 5).

5.5.1 Prevalence by state

Sabah showed the highest prevalence of wasting [19.3% (CI: 17.0 - 21.5)] followed by Perlis [19.0% (CI: 13.4 - 26.3)]. The WP Kuala Lumpur showed the lowest prevalence of wasting at 8.1% (CI: 6.3 - 10.4) followed by Pulau Pinang at 9.0% (CI: 6.8 - 11.7).

5.5.2 Prevalence by urban-rural strata

There was a higher prevalence of wasting in the urban areas [11.0% (CI: 10.2 - 11.9)] compared to the rural areas [9.5% (CI: 8.7 - 10.5)].

5.5.3 Prevalence by gender

There was an almost equal prevalence of wasting between girls [10.2% (CI: 9.4 - 11.1)] and boys [10.6% (CI: 9.8 - 11.5)].

5.5.4 Prevalence by ethnicity

Indians and the Others group had the highest prevalence of wasting at 16.8% (CI: 14.2 - 19.8) and 12.4% (CI: 9.4 - 16.3) respectively. In contrast, Chinese children had the lowest prevalence of wasting at 7.4% (CI: 6.1 - 8.9) followed by the Malays at 10.6% (CI: 9.8 - 11.5).

5.5.5 Prevalence by age

In general, the prevalence of wasting decreased with increasing age. Infants had the highest wasting prevalence of 15.2% (CI: 13.1 - 17.6), while the lowest prevalence was among those aged 10-13 years at 4.5% (CI: 3.3 - 6.0).

5.5.6 Prevalence by household monthly income

Households with the highest monthly income of \geq RM5000 showed the lowest prevalence of wasting at 8.0% (CI: 6.2 - 10.3), while the income category of <RM400 per month had the highest wasting prevalence [11.3% (CI: 9.2 - 13.7)].

6. DISCUSSION

This report highlighted the main findings of the Third National Health and Morbidity Survey conducted in 2006 (NHMS III). The previous two surveys namely, NHMS I and NHMS II conducted in 1986 and 1996 respectively did not include nutritional status of children. The NHMS II had a component on breastfeeding and complementary feeding, which was retained in the present NMHS III. Hence, for the first time, findings are presented on the national prevalence of the nutritional status of children aged 0 to below 18 years, based on a large nationally representative sample size of a total of 22,032 eligible children.

One of the main findings of the NHMS III is that the majority of the children aged between 0 to below 18 years in Malaysia had normal nutritional status according to the indicators of weight for age and height for age. The national prevalence of children with normal weight for age was 81.4% (CI: 80.8 - 82.0) and the different age groups, girls and boys, rural and urban areas and different income categories showed

prevalence above 70% for normal weight for age. Meanwhile the prevalence of Malaysian children with normal height for age was 80.5% (CI: 79.7 - 81.2). The various demographic and socio-economic groups also had prevalence higher than 70% for normal height for age.

The nutritional status of children in general can be said to have improved, concomitant with substantial progress in socio-economic development and health care services in Malaysia in the past decades. Although there is a lack of comparable data for direct comparisons, the prevalence of normal weight for age and height for age in the 1980s and 1990s were reportedly lower than the figures shown by the NHMS III. Khor & Tee (1998) reported that the prevalence of children aged 18 years and below from rural areas with normal weight for age and height for age was 73.8% and 72.6% respectively. Among poor rural communities, Chong et al. (1984) reported 63% of the children aged 1 to <6 years with normal weight for age and 57% with normal height for age.

However, despite commendable improvement, the problem of under-nutrition in the form of underweight and stunting still prevails. The states of Sabah, Perlis, Kelantan, Terengganu, Perak and WP Labuan had higher prevalence of underweight than the national prevalence of 13.2% (CI: 12.6 - 13.9). Meanwhile Sabah, Kelantan, Terengganu, Perak and WP Labuan showed stunting prevalence that exceeded the national prevalence of 15.8% (CI: 15.1 - 16.6). It is seen that some states showed high prevalence for both underweight and stunting. While underweight is the result of current or short-term under-nutrition, stunting reflects chronic or long-term nutritional deprivation. Hence, children in states like Sabah, Kelantan and Terengganu can be said to experience both chronic and current under-nutrition.

The NHMS III found the age group of 1-3 years particularly vulnerable to under-nutrition. This age group had the highest prevalence of underweight and stunting compared to infants and older children. Breastfeeding is likely to have ceased and complementary foods already given among children aged 1-3 years. Complementary foods with inadequate calories and nutrients can impair the nutritional status in this age group, which is undergoing rapid growth and development. Poverty, lack of access to appropriate nutritious foods and safe drinking water, ignorance about nutritional and health care, cultural influences and other factors are associated with growth impairment in young children. There is a need to identify the deleterious factors and challenges faced by parents and care-givers with respect to complementary feeding practices in Malaysia.

The national prevalence of overweight at 5.4% (CI: 5.0 - 5.7) appears comparable to the values previously reported. Overweight prevalence of 3.5% and 7.3% in school children aged 7-16 years in Kuala Lumpur were recorded by Kasmini et al. (1997) and Moy et al. (2004) respectively. Bong & Safurah (1996) found 9.8% overweight among primary one and primary six children in urban schools and 6.1% in rural schools in Selangor. Since obesity in childhood predisposes the child to cardiovascular disease and other chronic illnesses in adulthood, it is important to address the problem before the magnitude rises drastically higher. The NHMS III found that eight out of the 15 states and Federal Territories showed prevalence of overweight children that exceeded the national prevalence figure of 5.4% (CI: 5.0 - 5.7). Leading the list were WP Kuala Lumpur, Melaka and Negeri Sembilan followed by Selangor, Sarawak, Johor, Pulau Pinang and Perak.

It is envisaged that the prevalence of underweight among Malaysian children will continue to decrease, in light of on-going socio-economic development and nutrition improvement interventions in the country. On the other hand, the prevalence of overweight and obesity among children is expected to increase in the next decade. As factors contributing to overweight in childhood may be different in urban/rural

locations, different ethnic communities, age groups, sex and income categories, studies are needed to identify the contributing factors to obesity among children in the Malaysian context toward enhancing the effectiveness of public health interventions.

7. CONCLUSION

Globally, malnutrition remains a serious problem among children. It is estimated that among children under five years of age in the developing countries, 167 million are underweight, 206 million are stunted and 50 million are wasted. Malaysia appears to have a comparatively low prevalence of underweight and stunting compared with other developing countries.

The marked improvement in the nutritional status of Malaysian children reflects effective public health interventions as well as socio-economic development since Malaysia attained Independence. However, the prevalence of overweight is on the rise and the problem should be nipped in the bud. The findings of the NHMS III indicate the need for strengthening of public health policies and programmes that will further improve the health and nutritional status of children in Malaysia.

8. RECOMMENDATIONS

8.1 Sharing Responsibility

Strategies to improve the nutritional status of the Malaysian population are a shared responsibility of the various stakeholders. Both short term and long term strategies are required. The stakeholders should not involve only the government sector, but also others such as the food industry, non-government organizations, the media, professional societies and the community (e.g. schools, work sites). The key players need to share the responsibility and actively participate in the strategies planned by the programme managers.

8.2 Smart Partnership

Many strategies have been identified in the Second National Plan of Action (NPAN II 2006-2015) to combat nutritional problems in the population. In order to move forward these strategies, there is a need for continuous support and commitment by all stakeholders in a smart partnership. For example, the partnership among the food industry, NGOs, professional societies and government agencies to promote healthy lifestyles can be further enhanced..

8.3 Building and Strengthening Capacity of Trained Professionals

Trained professionals in nutrition, dietetics, food science as well as related fields such as psychology, physical activity and communications are needed to conduct studies and interventions in health promotion and reduction of the risks of non-communicable diseases. In this context, capacity building is imperative in order to strengthen these trained professionals to enable them to conduct effective health promotion activities in the targeted community.

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APPENDIX



APPENDIX 1

Table 1: Summary of measurements and equipment used to determine the nutritional status of children aged 0 to 18 years in the NHMS 3

Age group	Measurement	Equipment
Children < 2 years	Weight	TANITA digital weighing scale (TANITA 1583, Japan).
	Length	SECA measuring mat (SECA 210, Germany) and measuring tape.
Children \geq 2 years	Weight	TANITA digital weighing scale(TANITA 318, Japan)
	Height	SECA Bodymeter (SECA 206, Germany)

Table 2: Nutritional status indicators, Z scores and interpretations

Indicator	Z scores from NCHS median	Interpretation
Weight for age	below -2 SD*	Underweight
Weight for age	above +2 SD	Overweight
Weight for age	Between -2 SD and +2SD	Normal weight for age
Height for age	below -2 SD	Stunted
Height for age	above +2 SD	Tall
Height for age	Between -2 SD and +2SD	Normal height for age
Weight for height	below -2SD	Wasted

* SD: Standard Deviations

Table 3: Weight for age below 18 years by socio-demographic characteristics

Independent Variables	Weight for Age Categories														
	Underweight				Normal				Overweight						
	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%			
			Lower	Upper				Lower	Upper			Lower	Upper		
Total	2891	1035071	13.2	12.6	13.9	17266	6368131	81.4	80.8	82.0	1092	419446	5.4	5.0	5.7
Age group (Years)															
< 1	77	28092	7.1	5.7	8.9	940	349690	88.8	86.7	90.6	42	16235	4.1	3.1	5.5
1 - 3	680	244029	19.8	18.4	21.3	2563	951262	77.0	75.5	78.5	104	39547	3.2	2.6	3.9
4 - 6	638	228217	16.4	15.2	17.6	2931	1077519	77.3	75.8	78.6	231	88791	6.4	5.6	7.3
7 - 9	472	167118	11.9	10.8	13.0	3125	1147027	81.4	80.1	82.6	247	95295	6.8	6.0	7.7
10 - 13	481	170081	9.2	8.3	10.1	4280	1578678	84.9	83.8	86.0	287	110116	5.9	5.3	6.7
14 - 15	230	83302	10.2	9.0	11.6	1880	693058	85.0	83.4	86.5	101	38961	4.8	4.0	5.8
16 - < 18	313	114233	16.0	14.3	17.7	1547	570897	79.8	77.8	81.6	80	30502	4.3	3.4	5.3
Sex															
Male	1600	574099	14.5	13.7	15.3	8531	3158589	79.5	78.6	80.4	625	239359	6.0	5.6	6.5
Female	1291	460972	12.0	11.3	12.7	8735	3209542	83.4	82.5	84.1	467	180087	4.7	4.3	5.1
Race															
Malay	1868	679368	14.3	13.6	15.0	10443	3837111	80.7	79.9	81.5	624	237413	5.0	4.6	5.5
Chinese	159	63271	5.2	4.4	6.1	2695	1076781	87.8	86.5	89.0	216	86570	7.1	6.1	8.1
Indian	164	63366	10.5	8.8	12.5	1228	492848	81.4	79.2	83.4	122	49169	8.1	6.7	9.8
Other Bumis	565	185663	18.4	16.6	20.5	2378	783700	77.9	75.8	79.8	105	37259	3.7	2.9	4.6
Others	135	43404	18.9	14.7	23.9	522	177690	77.2	72.3	81.5	25	9035	3.9	2.5	6.0

Table 3: Weight for age below 18 years by socio-demographic characteristics (continue)

Independent Variables	Weight for Age Categories													
	Underweight				Normal				Overweight					
	N	Estimated	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%		
			Lower	Upper				Lower	Upper			Lower	Upper	
Strata														
Urban	1355	540643	11.4	10.7	12.2	9601	82.3	81.5	83.1	718	297232	6.3	5.8	6.8
Rural	1536	494428	16.0	15.1	17.1	7665	80.0	79.0	81.0	374	122214	4.0	3.5	4.5
Socioeconomic Status														
< RM 400	358	120143	21.4	18.9	24.2	1231	75.2	72.5	77.7	54	19111	3.4	2.6	4.5
RM 400 - < 700	621	209857	17.9	16.4	19.5	2715	79.1	77.4	80.7	99	35443	3.0	2.4	3.8
RM 700 - < 1000	399	140398	15.1	13.5	17.0	2077	80.7	78.8	82.5	108	38756	4.2	3.4	5.1
RM 1000 - < 2000	742	272322	12.4	11.5	13.4	4858	81.9	80.7	82.9	327	126145	5.8	5.1	6.5
RM 2000 - < 3000	355	132841	11.0	9.7	12.4	2646	83.7	82.1	85.2	167	64860	5.4	4.5	6.3
RM 3000 - < 4000	179	70257	11.4	9.7	13.4	1298	82.3	80.3	84.3	96	38671	6.3	5.1	7.6
RM 4000 - < 5000	49	18380	6.8	5.0	9.1	592	84.7	81.4	87.5	58	23321	8.6	6.4	11.3
RM ≥ 5000	111	43904	7.1	5.8	8.8	1288	83.6	81.4	85.7	142	56740	9.2	7.7	11.1
Unclassified	77	26968	10.8	8.2	14.0	561	82.7	79.1	85.8	41	16399	6.6	4.7	9.1
States														
Johor	255	97861	11.3	9.9	13.0	1857	82.6	80.8	84.3	137	52571	6.1	5.1	7.2
Kedah	200	71122	12.4	10.5	14.6	1340	83.5	81.2	85.6	66	23594	4.1	3.2	5.2
Kelantan	290	96012	16.8	14.7	19.1	1390	80.3	78.0	82.4	50	16598	2.9	2.2	3.9
Melaka	55	23203	12.6	9.1	17.1	358	80.3	75.8	84.1	31	13209	7.2	4.5	11.1
N.Sembilan	74	26490	10.2	7.8	13.2	591	82.7	79.0	85.8	50	18462	7.1	5.1	9.8
Pahang	145	54043	13.2	10.9	15.9	871	81.6	79.0	84.1	55	21112	5.2	3.9	6.8
Pulau Pinang	78	27203	9.0	6.8	11.7	735	85.1	82.0	87.7	50	18156	6.0	4.5	8.0
Perak	231	93339	14.4	12.3	16.9	1234	79.7	77.2	82.0	90	38209	5.9	4.7	7.3
Perlis	39	14272	19.0	13.4	26.3	150	75.6	69.1	81.1	10	4069	5.4	2.7	10.7

Table 3: Weight for age below 18 years by socio-demographic characteristics (continue)

Independent Variables	Weight for Age Categories											
	Underweight				Normal				Overweight			
	N	Estimated population	%	Confidence Interval 95% Lower Upper	N	Estimated population	%	Confidence Interval 95% Lower Upper	N	Estimated population	%	Confidence Interval 95% Lower Upper
Selangor	363	146699	10.6	9.4 12.0	2802	1142721	82.9	81.3 84.4	214	89105	6.5	5.6 7.5
Terengganu	165	54709	14.8	12.6 17.3	870	297082	80.2	77.4 82.8	54	18562	5.0	3.5 7.1
Sabah	611	186712	19.1	17.0 21.5	2501	766974	78.6	76.3 80.8	72	22305	2.3	1.7 3.0
Sarawak	262	99018	13.5	11.7 15.6	1507	588106	80.3	78.3 82.2	112	44963	6.1	5.1 7.4
W.P Kuala Lumpur	76	29913	8.1	6.3 10.4	773	304245	82.8	80.1 85.1	85	33455	9.1	7.2 11.4
W.P Labuan	47	14476	13.3	10.1 17.3	287	89203	82.0	77.8 85.6	16	5076	4.7	2.6 8.2
Educational level												
None	66	21694	24.6	18.7 31.7	201	65037	73.8	66.6 79.9	4	1400	1.6	0.5 5.1
Primary	1136	403897	10.1	9.5 10.8	9063	3342686	83.8	83.0 84.5	636	244717	6.1	5.6 6.7
Secondary	348	127681	15.0	13.5 16.6	1843	682650	80.3	78.5 81.9	105	40035	4.7	3.9 5.7
Unclassified	16	6197	19.0	11.5 29.8	64	23494	72.0	61.4 80.7	7	2937	9.0	4.1 18.5
Citizenship												
Malaysian	2741	988352	12.9	12.4 13.5	16845	6232476	81.6	81.0 82.3	1080	414890	5.4	5.1 5.8
Non-Malaysian	150	46719	25.7	21.1 31.0	410	131520	72.5	67.2 77.2	9	3263	1.8	0.9 3.7
Unclassified	0	0	0.0	0.0 0.0	11	4135	76.2	44.1 92.9	3	1294	23.8	7.2 56.0

Table 4: Height for age below 18 years by socio-demographic characteristics

Independent Variables	Height for Age Categories														
	Stunting						Normal						Tall		
	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper
Total	3454	1229024	15.8	15.1	16.6	16876	6241493	80.5	79.7	81.2	748	286461	3.7	3.4	4.0
Age group (Years)															
< 1	94	34893	9.0	7.4	11.1	824	304627	78.9	76.2	81.4	121	46586	12.1	10.1	14.3
1 - 3	582	207425	17.2	15.9	18.7	2404	890218	74.0	72.3	75.6	281	106094	8.8	7.8	10.0
4 - 6	649	231123	16.7	15.4	18.1	2942	1084134	78.3	76.8	79.8	181	68858	5.0	4.3	5.8
7 - 9	569	199714	14.2	13.0	15.5	3157	1163622	82.7	81.4	84.0	111	43426	3.1	2.5	3.7
10 - 13	788	277874	15.0	13.9	16.2	4208	1560213	84.1	82.9	85.3	41	16520	0.9	0.7	1.2
14 - 15	308	109698	13.5	12.1	15.1	1882	697367	86.0	84.5	87.5	9	3556	0.4	0.2	0.9
16 - < 18	464	168298	23.7	21.7	25.8	1459	541311	76.1	74.0	78.1	4	1421	0.2	0.1	0.5
Sex															
Male	1840	655649	16.6	15.7	17.5	8453	3138317	79.6	78.6	80.5	391	151007	3.8	3.4	4.3
Female	1614	573374	15.0	14.2	15.9	8423	3103177	81.4	80.5	82.3	357	135454	3.6	3.2	4.0
Race															
Malay	2147	778344	16.5	15.7	17.4	10311	3793588	80.5	79.6	81.4	372	142363	3.0	2.7	3.4
Chinese	236	93732	7.7	6.7	8.8	2663	1062978	87.4	86.0	88.7	147	59420	4.9	4.1	5.9
Indian	132	52012	8.7	7.1	10.5	1273	509316	84.9	82.6	87.0	96	38564	6.4	5.2	7.9
Other Bumis	772	250620	25.1	22.8	27.5	2159	716174	71.7	69.3	74.0	96	32323	3.2	2.6	4.0
Others	167	54315	23.9	19.6	28.7	470	159437	70.1	65.3	74.5	37	13791	6.1	4.2	8.7

Table 4: Height for age below 18 years by socio-demographic characteristics (continue)

Independent Variables	Height for Age Categories														
	Stunting						Normal						Tall		
	N	Estimated population	%	Confidence Interval 95%		N	Estimated population	%	Confidence Interval 95%		N	Estimated population	%	Confidence Interval 95%	
				Lower	Upper				Lower	Upper				Lower	Upper
Strata															
Urban	1599	635165	13.5	12.7	14.5	9443	3841448	81.9	80.9	82.9	518	212935	4.5	4.1	5.0
Rural	1855	593859	19.4	18.2	20.6	7433	2400045	78.2	77.0	79.4	230	73525	2.4	2.1	2.8
Socioeconomic Status															
< RM 400	407	134758	24.2	21.2	27.4	1180	406815	73.0	69.8	76.0	45	15976	2.9	2.1	4.0
RM 400 - < 700	693	232695	20.0	18.3	21.8	2652	908462	77.9	76.1	79.7	70	24423	2.1	1.6	2.7
RM 700 - < 1000	494	172580	18.8	17.0	20.8	1992	718792	78.3	76.2	80.3	73	26510	2.9	2.2	3.7
RM 1000 - < 2000	923	333769	15.4	14.2	16.6	4735	1756531	80.8	79.4	82.0	217	84453	3.9	3.3	4.5
RM 2000 - < 3000	444	167394	13.9	12.5	15.5	2576	987337	82.0	80.3	83.6	128	49803	4.1	3.4	5.0
RM 3000 - < 4000	174	67626	11.1	9.4	13.1	1317	517218	84.9	82.7	86.8	63	24484	4.0	3.1	5.2
RM 4000 - < 5000	63	24119	8.9	6.7	11.8	599	233055	86.0	82.6	88.8	35	13940	5.1	3.6	7.2
RM ≥ 5000	142	55748	9.2	7.2	11.6	1306	521242	85.7	83.1	87.9	78	31499	5.2	4.1	6.6
Unclassified	114	40335	16.3	13.2	19.9	519	192041	77.5	73.7	80.9	39	15372	6.2	4.4	8.7
States															
Johor	332	125888	14.7	12.9	16.8	1762	676448	79.1	76.9	81.1	136	52958	6.2	5.1	7.6
Kedah	198	69403	12.2	10.4	14.2	1367	490550	86.0	84.0	87.8	29	10557	1.9	1.3	2.6
Kelantan	319	105485	18.6	15.9	21.7	1359	449475	79.4	76.3	82.1	34	11290	2.0	1.4	2.9
Melaka	56	23245	12.6	9.0	17.4	371	154642	84.0	79.1	87.9	15	6246	3.4	2.0	5.7
N.Sembilan	76	27034	10.6	8.4	13.5	608	220718	86.9	83.9	89.4	17	6305	2.5	1.6	3.8
Pahang	164	60911	14.8	12.1	18.0	889	341551	83.2	80.1	86.0	20	7865	1.9	1.3	2.9
Pulau Pinang	85	29595	9.8	7.4	12.9	740	260629	86.3	83.3	88.8	34	11851	3.9	2.8	5.5
Perak	250	99665	15.6	13.2	18.4	1229	514739	80.8	77.9	83.4	53	22669	3.6	2.7	4.6

Table 4: Height for age below 18 years by socio-demographic characteristics (continue)

Independent Variables	Height for Age Categories														
	Stunting						Normal						Tall		
	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper	N	Estimated population	%	Confidence Interval 95% Lower	Confidence Interval 95% Upper
Perlis	29	10693	14.3	10.4	19.4	169	63939	85.7	80.6	89.6	0	0	0.0	0.0	0.0
Selangor	452	185025	13.5	12.0	15.3	2718	1105700	80.9	78.9	82.7	182	76517	5.6	4.7	6.7
Terengganu	178	59488	16.2	13.7	19.1	883	300694	81.9	78.9	84.6	19	6834	1.9	1.1	3.3
Sabah	858	261128	26.9	24.6	29.4	2208	678589	70.0	67.5	72.3	97	29951	3.1	2.5	3.8
Sarawak	295	112269	15.5	13.5	17.8	1517	591883	81.8	79.5	83.9	49	19702	2.7	1.9	3.8
W.P Kuala Lumpur	106	41721	11.4	9.0	14.4	774	304639	83.3	79.9	86.3	49	19286	5.3	3.8	7.2
W.P Labuan	56	17474	16.0	12.4	20.3	282	87497	80.0	75.3	83.9	14	4430	4.1	2.5	6.5
Educational level															
None	99	31711	36.1	29.9	42.9	168	55025	62.6	56.1	68.8	3	1103	1.3	0.4	3.7
Primary	1599	566426	14.2	13.4	15.1	9045	3349645	84.1	83.2	85.0	166	65353	1.6	1.4	1.9
Secondary	486	176996	21.0	19.2	22.9	1786	664698	78.8	76.9	80.6	6	2070	0.3	0.1	0.6
Unclassified	18	6621	21.3	13.7	31.6	60	22335	71.9	61.8	80.1	5	2127	6.8	2.6	16.8
Citizenship															
Malaysian	3280	1174688	15.5	14.8	16.2	16507	6122388	80.8	80.1	81.6	719	276196	3.7	3.4	4.0
Non-Malaysian	171	53304	29.9	25.2	34.9	361	115867	64.9	60.3	69.2	27	9397	5.3	3.6	7.6
Unclassified	3	1031	20.1	5.9	50.2	8	3237	63.0	36.3	83.6	2	868	16.9	3.1	56.4

Table 5: Weight for height below 13 years by socio-demographic characteristics

Independent Variables	Weight for Height Categories														
	Wasting				Normal				Overweight						
	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%			
			Lower	Upper			Lower	Upper			Lower	Upper			
Total	1297	479117	10.4	9.8	11.1	10248	3749173	81.6	80.8	82.3	981	368095	8.0	7.5	8.6
Age group (Years)															
< 1	154	57253	15.2	13.1	17.6	799	296513	78.6	75.9	81.1	61	23443	6.2	4.8	8.0
1 - 3	485	179568	15.1	13.8	16.5	2589	953230	79.9	78.4	81.4	162	60122	5.0	4.3	5.9
4 - 6	349	128613	9.4	8.5	10.4	3108	1136454	82.8	81.5	84.0	285	107574	7.8	7.0	8.8
7 - 9	267	98577	7.5	6.6	8.5	2986	1086781	82.7	81.3	83.9	345	129439	9.8	8.8	11.0
10 - 13	42	15107	4.5	3.3	6.0	766	276194	81.5	78.9	83.9	128	47516	14.0	11.9	16.5
Sex															
Male	730	270691	10.6	9.8	11.5	5579	2048172	80.3	79.3	81.3	617	230413	9.0	8.3	9.8
Female	567	208425	10.2	9.4	11.1	4669	1701001	83.1	82.0	84.1	364	137682	6.7	6.0	7.5
Race															
Malay	802	297718	10.6	9.8	11.5	6279	2302392	82.1	81.0	83.0	548	205747	7.3	6.7	8.0
Chinese	125	49117	7.4	6.1	8.9	1372	545819	82.3	80.2	84.2	172	68394	10.3	8.8	12.1
Indian	146	56553	16.8	14.2	19.8	632	251247	74.8	71.5	77.8	70	28320	8.4	6.5	10.8
Other Bumis	169	56897	8.9	7.5	10.5	1599	528975	82.7	80.7	84.6	157	53834	8.4	7.1	10.0
Others	55	18832	12.4	9.4	16.3	366	120739	79.8	75.7	83.3	34	11801	7.8	5.5	11.0
Strata															
Urban	753	304549	11.0	10.2	11.9	5490	2218159	80.2	79.1	81.2	597	244583	8.8	8.1	9.6
Rural	544	174568	9.5	8.7	10.5	4758	1531014	83.7	82.6	84.8	384	123511	6.8	6.0	7.6

Table 5: Weight for height below 13 years by socio-demographic characteristics (continue)

Independent Variables	Weight for Height Categories														
	Wasting				Normal				Overweight						
	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%	N	Estimated population	%	Confidence Interval 95%			
			Lower	Upper			Lower	Upper			Lower	Upper			
Socioeconomic Status															
< RM 400	111	41335	11.3	9.3	13.7	834	305077	83.2	80.4	85.6	55	20636	5.5	4.1	7.4
RM 400 - < 700	209	79589	10.4	8.9	12.1	1703	623125	84.1	82.2	85.8	112	42047	5.5	4.5	6.7
RM 700 - < 1000	156	58779	10.5	8.8	12.4	1251	457614	83.1	80.8	85.2	95	35644	6.4	5.1	8.1
RM 1000 - < 2000	366	138251	10.6	9.5	11.9	2861	1046553	81.4	79.9	82.8	275	103180	8.0	7.0	9.0
RM 2000 - < 3000	207	78222	11.1	9.5	13.0	1484	542847	79.2	77.1	81.3	177	66410	9.6	8.2	11.3
RM 3000 - < 4000	102	35086	10.8	8.8	13.3	754	275854	80.2	77.3	82.8	82	30766	9.0	7.3	11.0
RM 4000 - < 5000	40	13228	10.2	7.3	14.1	302	110471	77.1	71.6	81.8	50	18760	12.7	9.2	17.4
RM ≥ 5000	71	24215	8.0	6.2	10.3	730	267184	81.3	78.3	84.1	96	36019	10.7	8.6	13.2
Unclassified	35	10412	8.3	5.9	11.5	329	120448	81.7	77.6	85.2	39	14633	10.1	7.3	13.7
States															
Johor	170	64801	12.9	10.9	15.1	1037	398686	79.2	76.8	81.5	105	39854	7.9	6.5	9.6
Kedah	89	32143	9.6	7.6	11.9	794	283726	84.5	81.9	86.8	56	19854	5.9	4.6	7.6
Kelantan	92	30733	9.6	7.8	11.7	838	277128	86.2	83.5	88.5	41	13607	4.2	3.0	6.0
Melaka	26	10302	9.7	6.0	15.1	209	87182	81.7	76.2	86.2	22	9236	8.7	5.4	13.7
N.Sembilan	36	13093	8.8	6.4	12.0	342	123395	83.1	79.2	86.4	33	12037	8.1	5.7	11.4
Pahang	46	17355	7.4	5.4	10.1	524	200275	85.3	82.0	88.1	45	17215	7.3	5.1	10.4
Pulau Pinang	66	23288	13.2	10.3	16.8	406	141928	80.5	76.7	83.9	31	11003	6.2	4.5	8.7
Perak	97	40628	11.7	9.1	14.9	686	282624	81.4	77.9	84.4	57	24007	6.9	5.3	9.0
Perlis	11	4015	10.4	5.7	18.1	78	29819	76.9	69.6	82.9	12	4942	12.7	7.3	21.2
Selangor	252	102138	12.2	10.6	14.0	1592	650703	77.8	75.6	79.9	203	83325	10.0	8.6	11.6
Terengganu	56	19101	9.0	6.9	11.7	535	181541	85.7	82.8	88.3	32	11102	5.2	3.8	7.2

Table 5: Weight for height below 13 years by socio-demographic characteristics (continue)

Independent Variables	Weight for Height Categories											
	Wasting				Normal				Overweight			
	N	Estimated population	%	Confidence Interval 95% Lower Upper	N	Estimated population	%	Confidence Interval 95% Lower Upper	N	Estimated population	%	Confidence Interval 95% Lower Upper
Sabah	185	57086	9.3	7.9 10.9	1683	515549	83.8	81.7 85.6	140	42889	7.0	5.7 8.5
Sarawak	90	34655	8.0	6.4 10.0	915	353829	81.9	79.5 84.1	110	43481	10.1	8.3 12.2
W.P Kuala Lumpur	56	22041	10.4	7.7 13.8	409	160978	75.6	71.2 79.5	76	29913	14.1	10.9 17.9
W.P Labuan	25	7738	10.3	7.4 14.1	200	61809	82.2	77.7 86.0	18	5630	7.5	4.7 11.7
Educational level												
None	13	4373	9.7	5.9 15.4	121	38989	86.0	79.7 90.7	6	1954	4.3	1.9 9.3
Primary	331	122327	7.0	6.2 7.8	3960	1443381	82.2	81.0 83.3	508	190459	10.9	9.9 11.9
Secondary	0	0	0.0	0.0 0.0	0	0	0.0	0.0 0.0	0	0	0.0	0.0 0.0
Unclassified	3	1135	10.1	3.2 27.3	24	8660	76.9	58.3 88.8	4	1473	13.1	4.9 30.5
Citizenship												
Malaysian	1236	459591	10.3	9.7 11.0	9907	3641210	81.6	80.8 82.4	955	359720	8.1	7.5 8.6
Non-Malaysian	60	19092	14.3	11.0 18.4	336	106146	79.4	75.0 83.2	26	8375	6.3	4.3 9.1
Unclassified	1	434	19.3	2.7 67.2	5	1817	80.7	32.8 97.3	0	0	0.0	0.0 0.0

APPENDIX 2

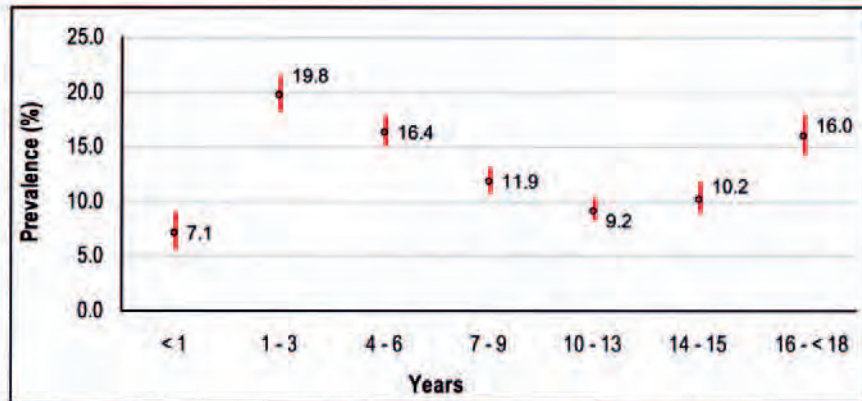


Figure 1: National prevalence of underweight in Malaysian children aged below 18 years by age groups

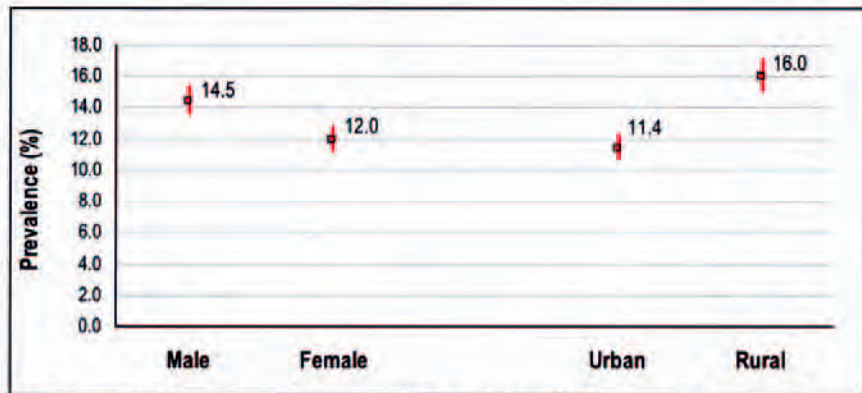


Figure 2: National prevalence of underweight in Malaysian children aged below 18 years by gender & strata

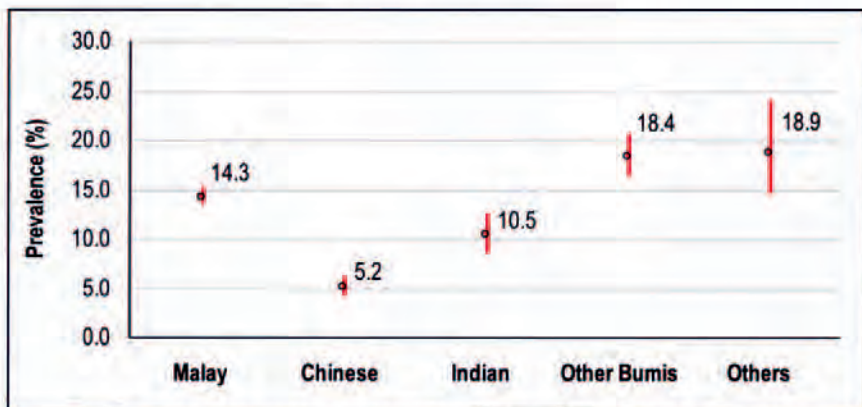


Figure 3: national prevalence of underweight in Malaysian children aged below 18 years by ethnic group

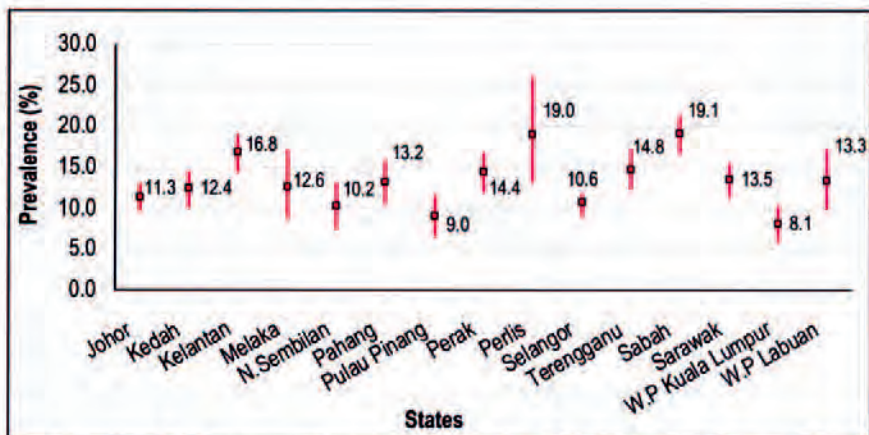


Figure 4: National prevalence of underweight in Malaysian children aged below 18 years by State and Federal Territory

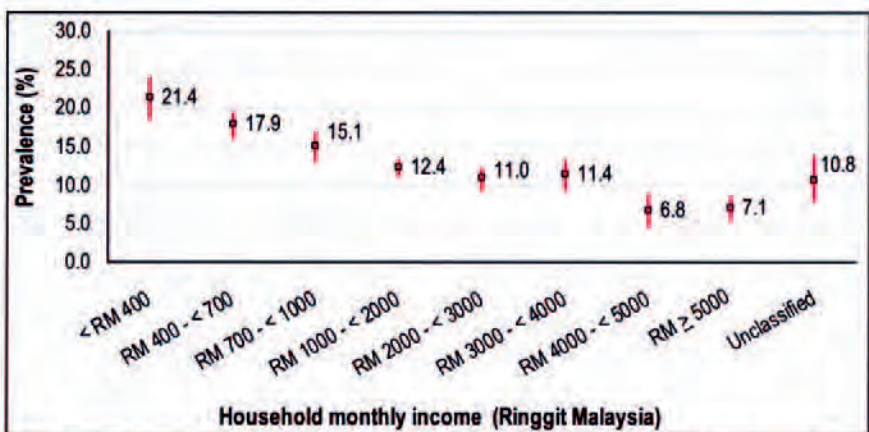


Figure 5: National prevalence of underweight in Malaysian children aged below 18 years by household monthly income

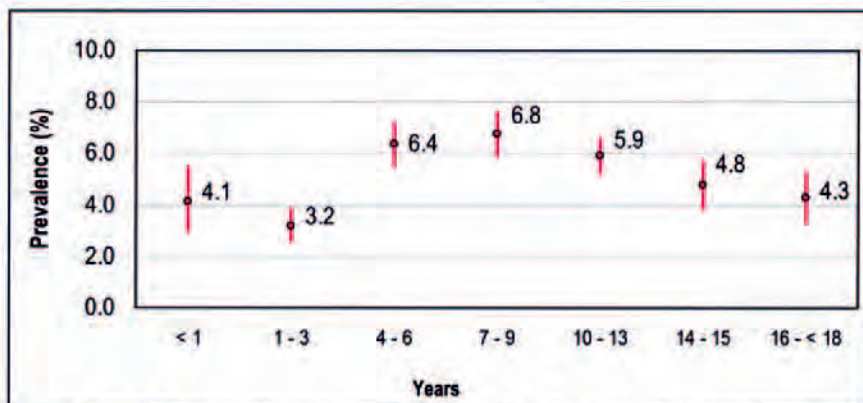


Figure 6: National prevalence of overweight in Malaysian children aged below 18 years by age group



Figure 7: National prevalence of overweight in Malaysian children aged below 18 years by gender & strata

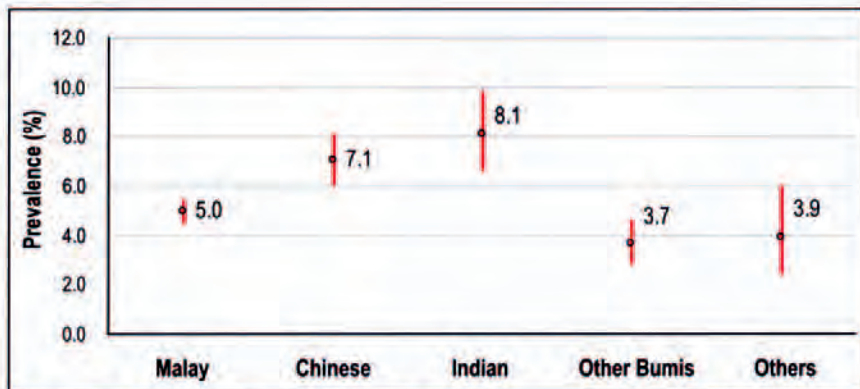


Figure 8: National prevalence of overweight in Malaysian children aged below 18 years by ethnic group

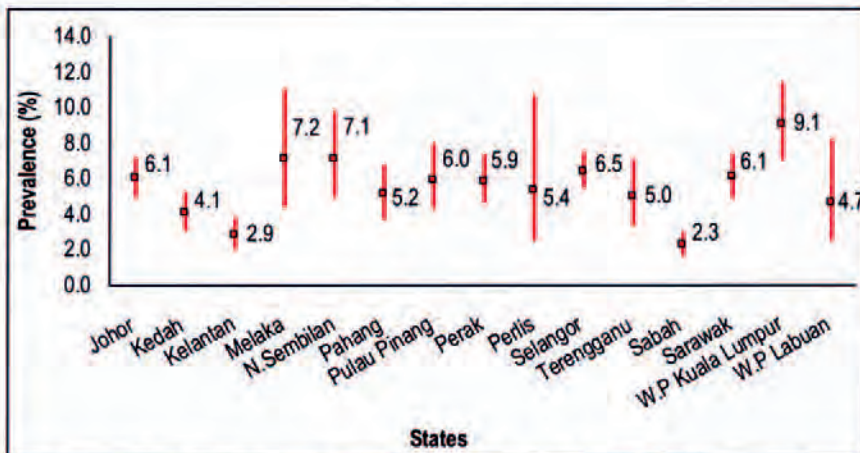


Figure 9: National prevalence of overweight in Malaysian children aged below 18 years by State and Federal Territory

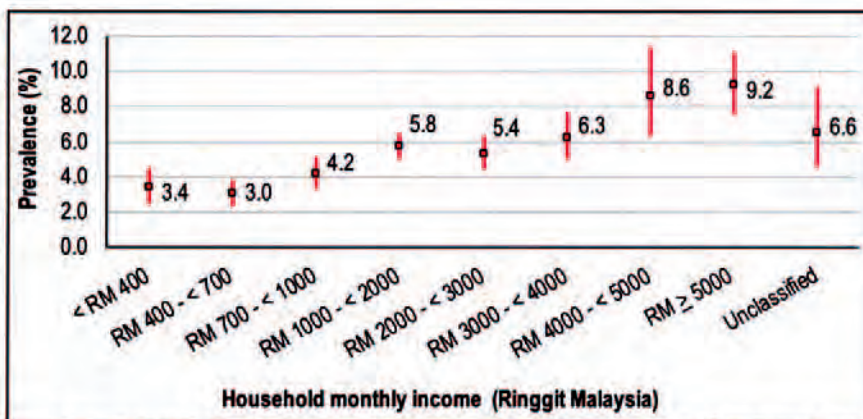


Figure 10: National prevalence of overweight in Malaysian children aged below 18 years by household monthly income

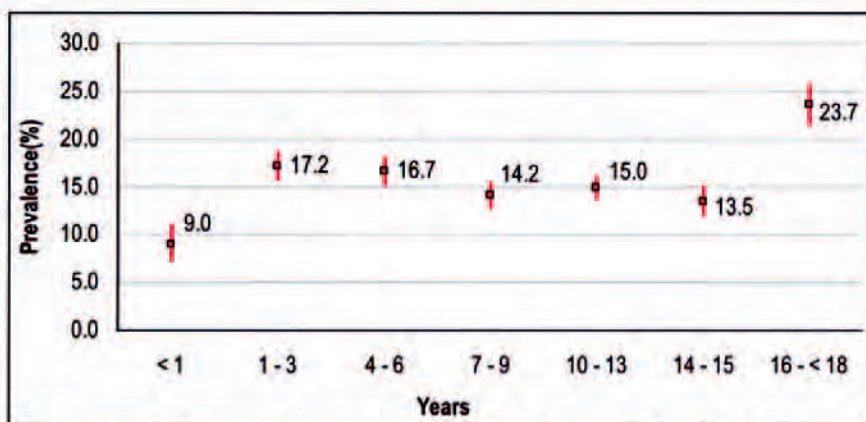


Figure 11: National prevalence of stunting in Malaysian children aged below 18 years by age group

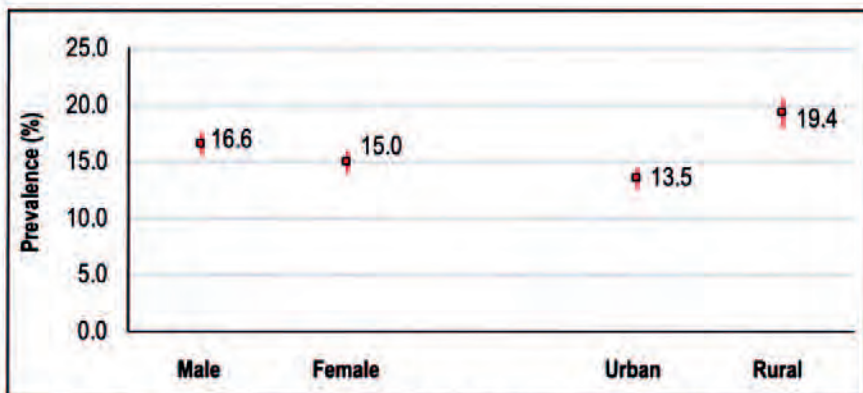


Figure 12: National prevalence of stunting in Malaysian children aged below 18 years by gender and strata

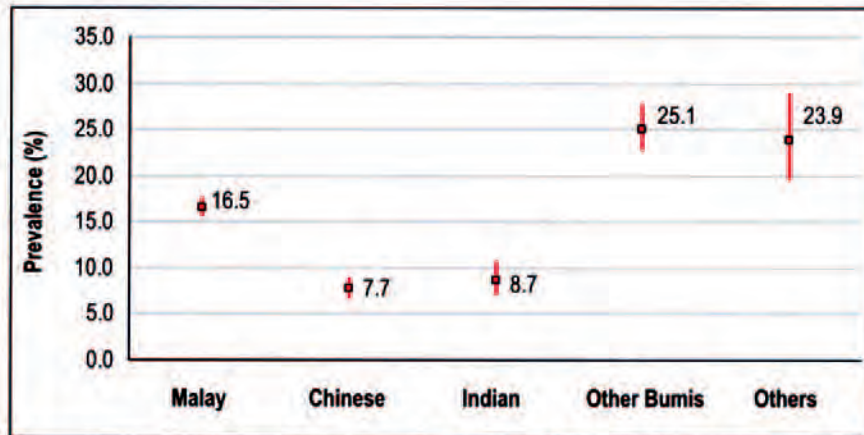


Figure 13: National prevalence of stunting in Malaysian children aged below 18 years by ethnicity

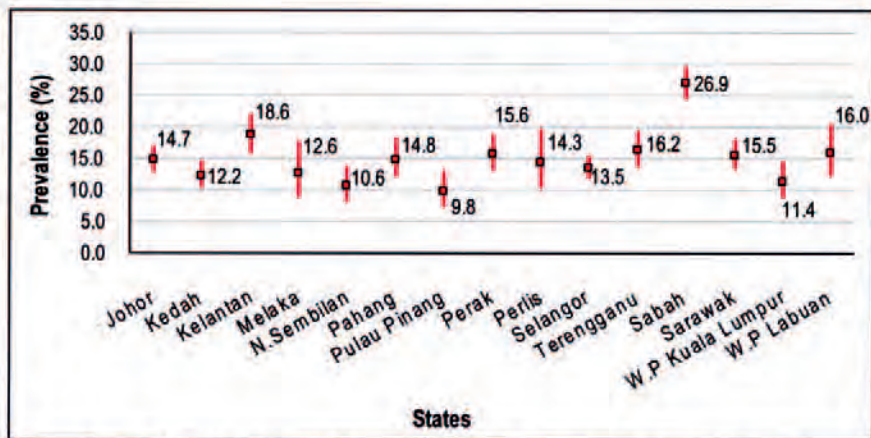


Figure 14: National prevalence of stunting in Malaysian children aged below 18 years by State and Federal Territory

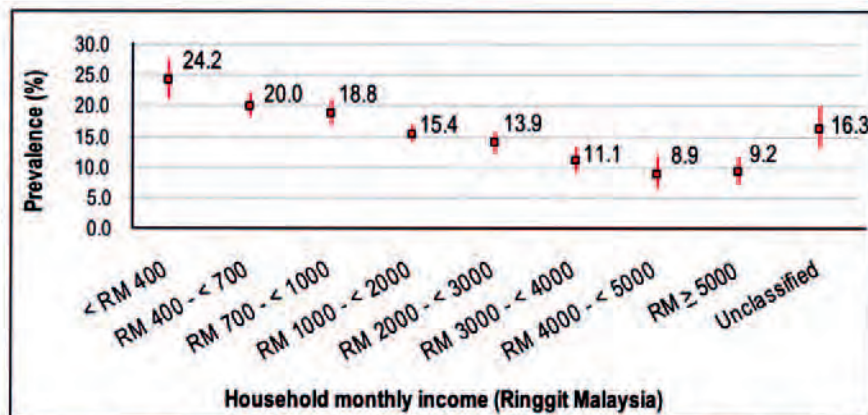


Figure 15: National prevalence of stunting in Malaysian children aged below 18 years by household monthly income

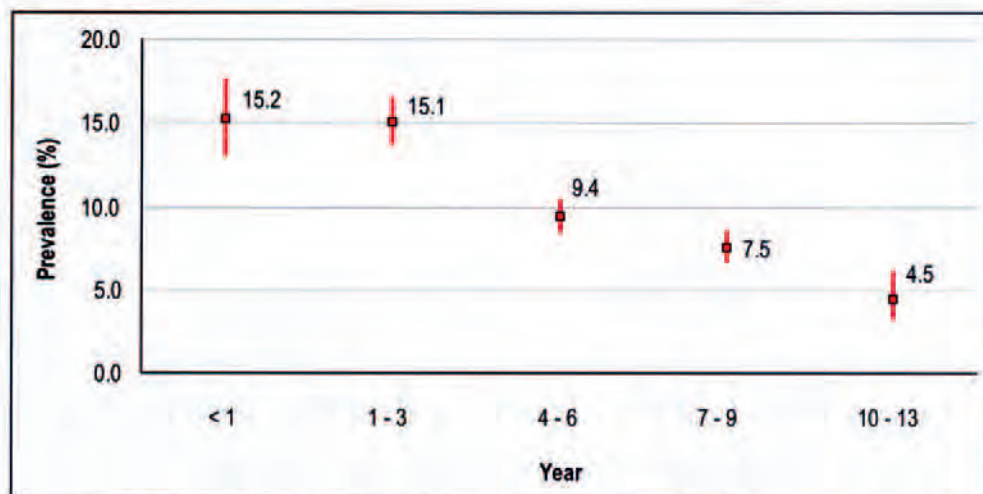


Figure 16: National prevalence of wasting in Malaysian children aged below 13 years by age groups

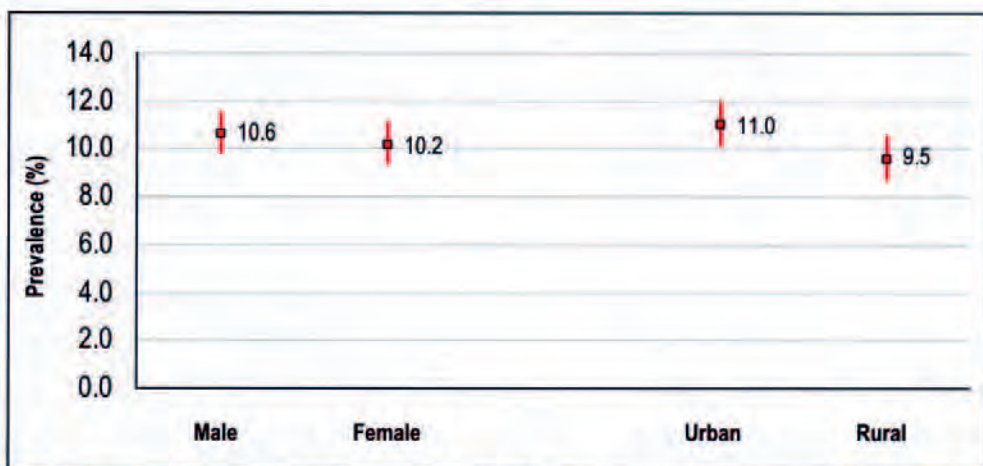


Figure 17: National prevalence of wasting in Malaysian children aged below 18 years by gender and strata

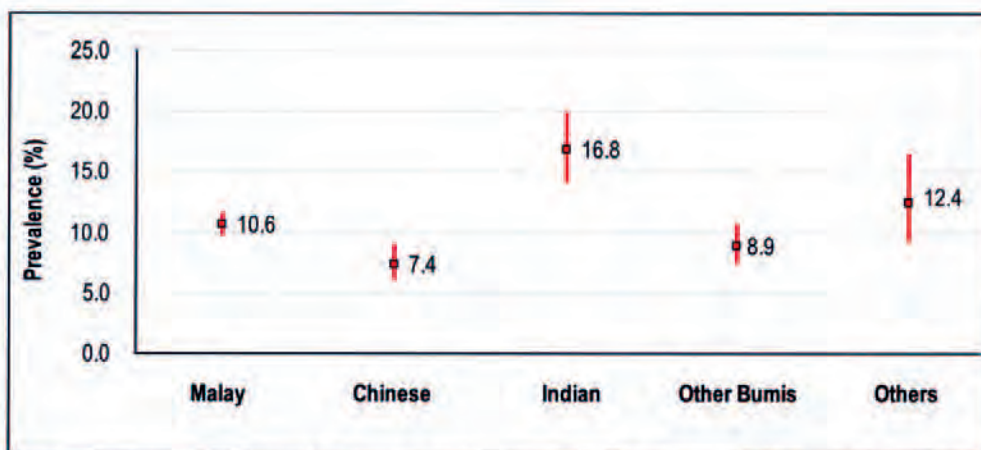


Figure 18: National prevalence of wasting in Malaysian children aged below 18 years by ethnic groups

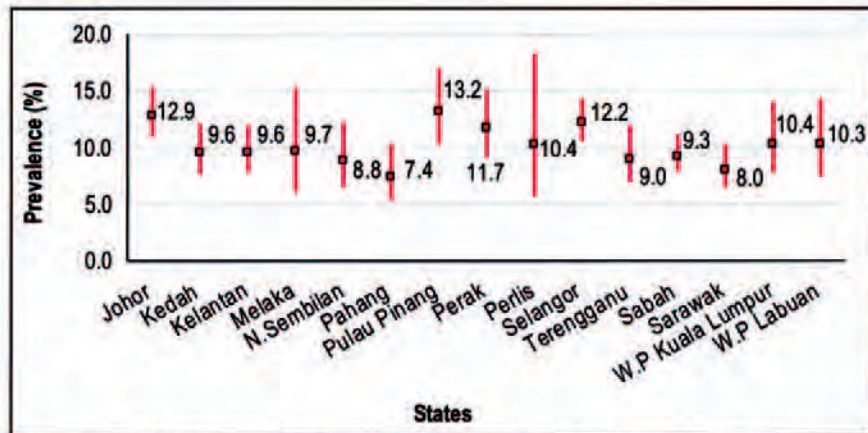


Figure 19: National prevalence of wasting in Malaysian children aged below 18 years by State and Federal Territory

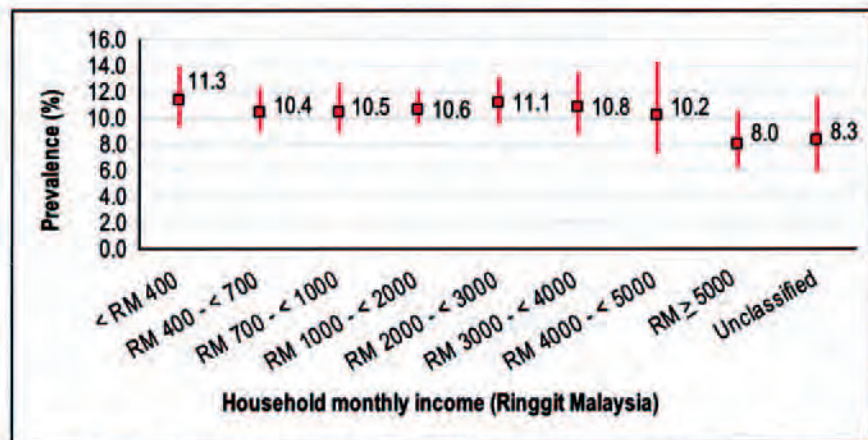


Figure 20: National prevalence of wasting in Malaysian children aged below 18 years by household monthly income

APPENDIX 3

Reliability and Validity of Measurements Used in the NHMS III (2006) for Nutritional Status Assessment in Children

Measurement of the inter and intra-examiner reliability of weight (WT) and length (LT) and the validity of test instruments for measuring WT and LT compared to their reference instruments was done prior to the actual field study. A convenience sample of 130 clinically stable children less than 2 years old from the Hospital Universiti Kebangsaan Malaysia (HUKM) paediatric outpatient clinics were recruited during the period of December 2005 to January 2006. Two public health nurses, trained to follow a standard protocol, obtained the measurements. Weight was measured using Tanita digital weighing scale, 1583, Japan (0.01kg) and Seca beam scale, Germany (0.01 kg) weighing machines. Length measurement was done using Seca measuring mat (0.1cm) and Stadiometer, Germany (0.1cm). The mean age of respondents was 279.3 ± 186.4 days. There were almost equal number of male and female (57.69% and 42.31% respectively) and the highest ethnic group was Malay with 70% followed by Chinese 24.6% and Indians 3.1%.

There was a high degree of reliability (both inter and intra examiner) as evidenced by low to nil absolute mean difference and high values of intra-class correlation (ICC is =1 or close to 1) for both WT and LT. For inter-examiner, the Bland and Altman plot on average showed that, the LT measurements taken by the first examiner are 0.1 cm higher than the second examiner. The upper and lower limit of differences are ± 4 cm. Inter-examiner WT measurements on average are consistent (mean difference = 0) with upper and lower limit at ± 0.2 kg. By comparison inter-examiner WT measurements are more reliable than LT measurements. For intra-examiner, the Bland and Altman plot on average showed that, the LT measurements at Time1 are 0.1 cm lower than Time2. The limits of the difference was +3.6 and -3.8 cm. WT measurements at Time1 and Time2 on average is consistent (mean difference = 0) with upper limit and lower limit at ± 0.2 kg. By comparison the intra-examiner WT measurements for examiner 1 are more reliable compared to that of LT measurements.

There was a high degree of validity as evidenced by low to nil absolute mean difference and high values of intra-class correlation (r close to 1) for both WT and LT. The Bland and Altman plot for LT measurements showed that on average, the test instrument was recording 0.2 cm higher than the reference instrument, with limits at ± 2 cm. WT measurements using test instrument and reference instrument on average is consistent (mean difference = 0) with upper limit and lower limit at ± 0.2 kg. The coefficients of variations of both WT and LT for inter-examiner and intra-examiner measurements are within acceptable limit (below 5%).

The findings of this study suggest that weight and length measured in infants and children less than two years using the Tanita digital weighing scale, 1583, Japan (0.01kg) and Seca measuring mat Germany (0.1cm) are reliable and valid to be used in a community survey. The study suggests limiting the number and types of examiners for length measurements, which seems to be more challenging compared to weight measurements.

APPENDIX 4

Report on Data Quality Control for NHMSIII Nutritional Study

1. INTRODUCTION

The purpose of this paper is to report the data management process for nutritional data (Module U). The data were entered into a customised system developed for NHMS III. The system was designed using MySQL as the database. The interface was developed using Microsoft Visual Basic. The original data were stored in SQL format and extracted to individual module. The SQL format file was then converted to Microsoft Excel format. Module U that contained nutritional data was then merged with Module A1 that contained information on socio-demographics. Merged dataset was then checked against eligibility criteria. Eligible subjects were then divided into adult and paediatric dataset based on reported age available in Module A1.

2. FINDINGS

2.1 Case Numbers

Figure 1 summarises the process of data cleaning at the initial phase of the analysis. In-total there were 3,430 missing value, with 3,268 data without socio-economic information, 110 data without information on eligibility and 54 data with no age information. These missing values together with not eligible subjects were dropped from the dataset. The final pre-cleaned data for children was 22,034.

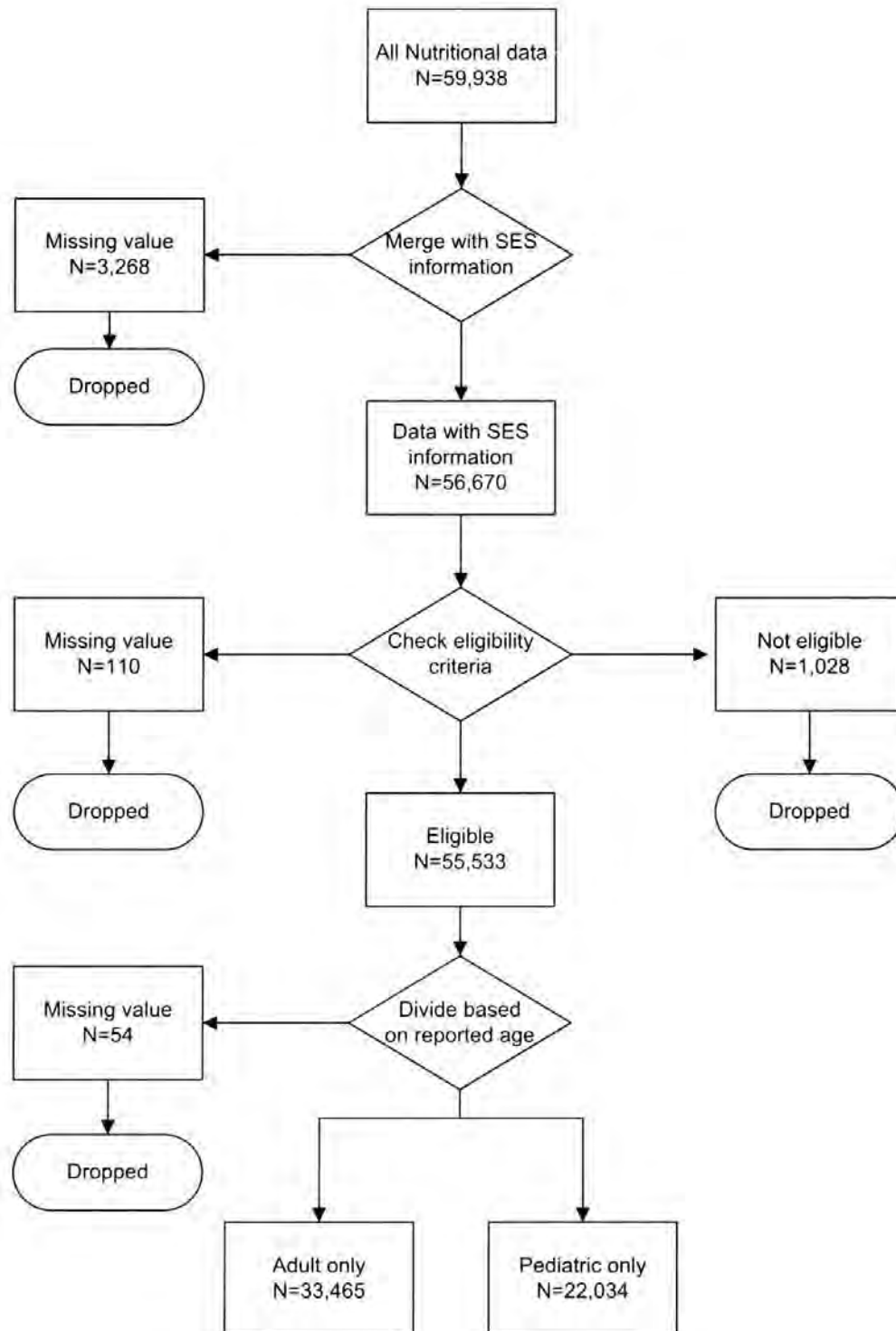


Figure 1: Summary of Eligible Data for Analysis

There were 1028 respondents who had health conditions that may affect nutritional status and therefore were also excluded from the study. The conditions are illustrated in Table 1.

Table 1: Health conditions that affect nutritional status

		N	%
1	Tuberculosis	606	58.9
2	Chronic Renal Diseases	109	10.6
3	Asthma	41	4.0
4	Thyroid Diseases	43	4.2
5	Congenital Heart Diseases	187	18.2
6	Blood Diseases	41	4.0
7	Cancer	1	0.1

2.2 Paediatrics Nutritional Data

There were three important variables that were cleaned; age, weight and height.

2.2.1 Age

The age is defined as age in month reported by the parents or guardian. However, there were 48 missing values. For these cases, the age in months was calculated from the date of birth to the date of visit. Unfortunately there were 7 cases with no birth date documented. Out of these 7 cases, only 2 cases were children age below 2 years old (ID 080312014100180102 and 080312014100180103). These cases were considered as missing values. The final description of cleaned age is presented in Table 2.

Table 2: The Final Cleaned data for Age (Month) for NHMS III Paediatrics Nutritional Data

	N	Minimum	Maximum	Mean	SD
Age (month)	22032	0	215	105	60

2.2.2 Weight and Height

Weight was measured in kilogram and height in centimetre. Both variables were measured twice, and average of the measurements was taken. Description of the measurements is as depicted in Table 3.

Table 3: Summary of Pre-cleaned Weight and Height for NHMS III Paediatrics Nutritional Data

	N	Minimum	Maximum	Mean	SD
Weight (1st)	21350	1.7	183	30.11	19.10
Weight (2nd)	21328	1.7	183	30.12	19.13
Height (1st)	21263	4.1	1749	124.18	31.92
Height (2nd)	21236	2	1749	124.16	31.96

Not all measurements were available (refer Table 4). Single missing value was 0.1% for both variables and complete missing values were less than 4%. Single missing values were imputed from the other measurement.

Table 4: Summary of Missing Values

	Missing Single Measurement		Missing Two Measurements	
	N	%	N	%
Weight	24	0.1	682	3.1
Height	27	0.1	771	3.5

Data entry error detected was small (< 0.05%) (Table 5). Data were checked with original questionnaire forms and then corrected accordingly.

Table 5: Summary of Data Entry Errors for NHMS III Paediatrics Nutritional Data

Problems identified	Measurements	
	Weight N (%)	Height N (%)
Obvious decimal error	2 (0.009) ¹	-
Obvious typing error	2 (0.009) ²	11 (0.050) ³

Standardised height for age (HAZ), weight for height (WHZ) and weight for age (WAZ) was done. Valid values were defined as HAZ and WAZ within ± 6 SD; and WHZ from -4 SD to +6 SD.

¹ ID involved are 100235082100180105 and 100850003201010102.

² ID involved are 140122039105340107 and 100732096201740104.

³ ID involved are 131133003500280103, 110509056400430106, 100305086400220105, 120942033600290107, 100872044100770104, 050406075400380103, 120406002600020103, 100567047101640104, 110203127200260103, 130104079100080105 and 040305027200660104.

CHAPTER II

**NUTRITIONAL STATUS OF ADULTS
(AGED 18 YEARS AND ABOVE)**

ABSTRACT

Chapter II: Nutritional Status of Adults (Aged 18 Years and Above)

Nutritional status is an important component of the health of a population. The Third National Health and Morbidity Survey (NHMS III) conducted in 2006 included nutritional status assessment as one of the components in the investigation into the health of the Malaysian population. Body mass index (BMI) was calculated using weight and height measurements among 33,055 eligible individuals aged 18 years and above. Risk of abdominal obesity was obtained based on waist circumference measurement among 32,900 individuals. In addition, peripheral muscle wasting was determined using calf circumference measurement among 4,282 individuals aged 60 years and above.

Among adults aged 18 years and above, the proportion having normal BMI (BMI 18.5-24.9kg/m²) was 48.4% (CI: 47.7 - 49.0), with 52.0% (CI: 51.2 - 52.9) in men and 45.3% (CI: 44.5 - 46.1) in women. The prevalence of underweight (BMI <18.5kg/m²) was 8.5% (CI: 8.2 - 8.9), the level being almost similar in both men [8.3% (CI: 7.8 - 8.8)] and women [8.7% (CI: 8.3 - 9.2)]. Underweight prevalence among adults was higher in the rural [9.8% (CI: 9.2 - 10.4)] than the urban areas [7.8% (CI: 7.4 - 8.3)].

Meanwhile, 29.1% (CI: 28.6 - 29.7) of the adult population was found to be overweight (BMI 25.0-29.9 kg/m²). Overweight prevalence increased with age, particularly after 35-39 years until 60-64 years after which the prevalence declines. Among the ethnic groups, Indians had the highest prevalence of overweight [33.2% (CI: 31.4 - 35.1)], followed by Malays [29.77% (CI: 29.1 - 30.5)] and Chinese [28.5% (CI: 27.3 - 29.6)]. Within the job category, the senior officers and managers group as well as the technical and associate categories had the highest overweight prevalence.

This study also identified 14.0% (CI: 13.6 - 14.5) of the adults as obese (BMI >30.0kg/m²). Out of this, 10.5% (CI: 10.1 - 10.8) was in the obese I (BMI 30.0-34.9 kg/m²) category, 2.58% (CI: 2.40 - 2.78) in obese II (BMI 35.0-39.9 kg/m²) and 1.0% (CI: 0.85 - 1.07) in obese III (BMI > 40.0 kg/m²) categories. Women had higher obesity prevalence at 17.4% (CI: 16.7 - 18.0) than men at 10.0% (CI: 9.5 - 10.5). Obesity prevalence increased with age, particularly at 45-49 years until 50-54 years after which the prevalence declined. Ethnicity-wise, Indians and Malays had higher obesity prevalence [17.7% (CI: 16.3 - 19.3)] and [16.6% (CI: 16.0 - 17.3)] respectively than the Others group. According to the job category, housewives had the highest prevalence of obesity at 20.3% (CI: 19.4 - 21.3).

The prevalence of abdominal obesity (waist circumference for women > 88cm and men > 102cm) was 17.4% (CI: 16.9 - 17.9), with women showing a higher prevalence [26.0% (CI: 25.2 - 26.8)] than men [7.3% (CI: 6.7 - 7.6)].

Among older persons (aged 60 years and above), the prevalence of those with peripheral muscle wasting (calf circumference for women < 27.3cm and men ≤ 30.1cm) was 19.9% (CI: 18.5 - 21.6). A higher proportion of men [23.7% (CI: 21.6 - 25.9)] than women [16.8% (CI: 15.1 - 18.5)] was at risk of malnutrition according to this indicator.

There were key differences in the nutritional status of Malaysian adults when compared with those reported in the Second National Health and Morbidity Survey (NHMS II) undertaken in 1996. Firstly, the prevalence of underweight of 8.5% was three times lower than the finding of 25.2% in the NHMS II. In

contrast, the prevalence of overweight has increased from 16.6% in the NMHS II to 28.6% in the present study. The latter is comparable with the finding of 27.4% reported in another nationally representative sample involving over 5,000 adults namely, the Malaysian Adults Nutrition Survey (MANS) conducted in 2003. It is noted that obesity prevalence of 14.2% in this study and 12.7% in the MANS were approximately three times the level of 4.4% found in 1996 (NHMS III). This alarming trend calls for immediate revision of public health policies and for effective programmes in prevention and intervention strategies.

1. INTRODUCTION

Malaysia has undergone rapid pace of socioeconomic development including industrialisation and urbanisation since the country attained independence in 1957. Concomitant with these developments are increased availability of food products and lifestyle changes leading to shifts in dietary practices, food preferences and physical activity levels. These shifts are known to be associated with changes in the population health and non-communicable disease patterns namely, coronary heart disease, diabetes, hypertension and cancer (Tee 1999).

Similar to other countries that are undergoing the nutrition transition, Malaysia bears the dual problem of malnutrition. While underweight and stunting in children continue to be reported especially in low-income households, overweight in adults has emerged as a public health issue (Tee 1999). Meanwhile, micronutrient deficiency including iron deficiency, iodine deficiency disorders and vitamin A deficiency also affect young children, women of childbearing age and the elderly (MOH 2005).

Against this backdrop, the National Nutrition Policy was promulgated to ameliorate the country's nutritional challenges toward enhancing the nutritional wellbeing of the people (NCCFN 2006). This Policy was formulated as an outcome of the First National Plan of Action for Nutrition (NPAN I) for the period of 1996-2000. The main thrust of NPAN I was aimed at supporting strategies for combating the burden of nutritional deficiencies and diet-related chronic diseases. The strategies of NPAN I were expanded and reinforced in the current NPAN II (2005-2015) through the following thrust areas:

- improving breastfeeding and complementary feeding practices
- improving food intake and dietary practices
- reducing protein–energy malnutrition
- reducing micronutrient deficiency
- reducing overweight and obesity
- preventing and controlling diet-related non-communicable diseases

Among the targets identified in the NPAN II was that the prevalence of overweight and obese adults would not exceed 30% and 15% respectively by the year 2015.

In 1996 when the Second National Health and Morbidity Survey (NHMS II) was undertaken, body mass index (BMI) was reported for Malaysian subjects aged 18 years and above (Fatimah et al. 1997). The first national nutrition survey (MANS) on adults aged 18-59 years conducted between 2002 and 2003 also included BMI data, together with food consumption and physical activity patterns (MANS 2003). The recent Malaysian Non-communicable Disease Surveillance 1 (MyNCDS-1) in 2006 included BMI, and waist and hip circumferences measurements for adults up to 64 years old.

At the time of embarking on the NMHS III, it was deemed essential to obtain important data pertaining to nutritional status that had not been reported previously in NHMS II. Thus, the NHMS III has included waist circumference beside body mass index. In addition, calf circumference was measured to estimate risk of malnutrition of older persons.

The NHMS III has also included assessment of the nutritional status of children aged below 18 years, which was not covered in neither NHMS I and NHMS II. This report presents the methodology and

findings on the nutritional status of adults (individuals aged 18 years and above), whilst a similar report on children (individuals below 18 years) is presented in a separate report.

2. LITERATURE REVIEW

Nutritional status is an important determinant of health of the population. In assessing nutritional status, anthropometry is one of the key tools used. It encompasses a variety of body measurements such as weight, height/length, waist circumference and skin fold thicknesses. Based on weight and height measurements, the body mass index (BMI) is computed and is a commonly used indicator of adult nutritional status.

2.1 Underweight

In developing countries there is evidence that individuals with a low BMI showed a progressive increase in mortality and increased risk of illness (Jia et al. 2002; Moon et al. 2002; Jafar et al. 2006). Underweight especially among the women in their reproductive years is linked to maternal health problems such as anemia during pregnancy, premature delivery and low birth weight.

In Malaysia, the Second National Health and Morbidity survey (NHMS II 1996) reported that the national prevalence of underweight in adults aged 18 years and above was 25.2% with slightly higher prevalence in women (25.9%) than men (24.4%) (MANS 2003). Another study on adults found underweight prevalence among Malay men and women of 7.0% and 11.0% in urban areas and 11.0% and 14.0% in rural areas respectively (Ismail et al. 1995).

However, with rapid economic growth and improvements in infrastructure and services, the nutritional status of the people has shifted from a decrease in the prevalence of underweight to a rise in overweight and obesity among adults. Increased intake of calories, vegetable oils, refined carbohydrate and decreased intake of complex carbohydrates, coupled with more sedentary lifestyle have been implicated in the continued increase in the prevalence of obesity and diet-related non-communicable chronic diseases (Tee 1999).

2.2 Overweight and Obesity

The problem of overweight and obesity poses a public health threat worldwide with increasing prevalence among children and adults (James 2004; Tee 2002). Many factors contribute to overweight and obesity including age, gender, socioeconomic status, educational level, dietary intake, physical activity and genetics. Overweight and obesity are key determinants of non-communicable diseases such as hypertension, hypercholesterolemia, diabetes mellitus and several types of cancer (Jia et al. 2002; Moon et al. 2002; Jafar et al. 2006). These diseases increase health-care burden leading to premature deaths.

In Malaysia, past cross-sectional studies have reported on the problem of overweight in adults. In a study among adults, the prevalence of overweight in men from urban areas was found at 24% and obesity at

4.7%, compared to 18.1% and 7.9% respectively in women (Ismail et al. 1995). In comparison among ethnic groups, the prevalence of overweight and obesity was highest among the Indians (29.8% and 16.5% respectively), followed by Malays (19.8%, 8.8%) and Chinese (12.0%, 4.3%). Another study in rural communities also found that women had higher prevalence of overweight (32.4%) and obesity (13.6%) than men, among whom, 18.3% was overweight and 5.2% were obese (Ng et al. 1993).

In 1996, the NHMS II undertaken on a nationally representative sample found the prevalence of overweight and obesity in the adult population (18 years and above) at 16.6% and 4.4% respectively (Fatimah et al. 1997). Prevalence of overweight among women (17.9%) was higher than that in men (15.1%). However, the prevalence of obesity among women (5.7%) was found to be twice that of men (2.9%).

The Malaysian Adult Nutrition Survey (MANS) conducted between 2002 and 2003 reported that 26.7% of adults (aged 18-59 years) were overweight and 12.2% obese (MANS 2003). More women (14.7%) than men (9.7%) were obese, while the level was lower among younger adults (18-19 years) compared to older adults (50-59 years). The prevalence of obesity was highest among the Malays (15.3%) and lowest among the Chinese (7.2%).

In the United States, the prevalence of overweight and obesity has been steadily increasing over the years. Results from the Fourth National Health and Nutrition Examination Survey (NHANES) in 1999 to 2002 indicated that among the adult population, approximately 65.1% were overweight or obese (BMI \geq 25.0), 30.4% were obese (BMI \geq 30.0), and 4.9% were extremely obese (BMI \geq 40.0) (Wright et al. 2002). In United Kingdom, the annual Health Survey showed the prevalence of obesity has more than tripled in the past 20 years (Rennie & Jebb 2005). In 1980, just 6.0% men and 8.0% women were classified as obese (BMI $>$ 30.0), whereas by 2002, 23.0% of men and 25.0% women were obese.

Obesity is no longer considered a concern of the developed countries only, as evidenced by its increased prevalence in developing countries in Asia. In Korea, the prevalence of obesity among adults increased rapidly to 30.6% in 2001 from 13.9% in 1995 (Kim et al. 2005). A similar trend was observed in Thailand. In 1991, the National Health Examination Survey of Thailand reported that 16.7% of the adult population was overweight while 4.0% were obese (Kantachuvessiri 2005). The prevalence figures had almost doubled by 1997, with 28.3% overweight and 6.8% obese. In Taiwan the prevalence of obesity has also increased significantly for the past 10 years (Chu 2005). The nutrition survey conducted in 1993-1996 had reported 21.6% of adults overweight (BMI $>$ 24) and 12.2% obese, and these figures had increased to 23.8% and 13.3% respectively in 2000-2001 (Chu 2005).

2.3 Abdominal obesity

While BMI serves as an indicator of overall overweight, waist circumference has been established as an important indicator of abdominal obesity. Excess abdominal fat is an independent risk factor of non-communicable diseases. In older persons, abdominal obesity or high waist circumference was found to be a better predictor of mortality than BMI (Janssen et al. 2005).

Results from a large scale International Day for the Evaluation of Abdominal Obesity (IDEA) study, which involved a random sample of more than 6000 primary care practitioners in 63 countries and a total of over 170,000 adults' individuals, confirmed that a high waist circumference is associated with cardiovascular

disease, independently of body mass index (BMI) and age (Balkau et al. 2007). The IDEA study included examining waist circumference of 30,783 individuals (50.0% men) in three Asian regions (12 Asian countries) (Bassand 2006). The prevalence of abdominal obesity according to WHO classification and NCEP/ATP III cut off points (>102 cm in men and >88 cm in women) ranged from 6.0% (East and South East Asia) to 20.0% (South Asia) in men and from 22.0% (East and South East Asia) to 55.0% (South Asia) in women (WHO 1998). Data on waist circumference was reported in the Malaysian Non Communicable Disease Surveillance (MyNCDS-1) among 2572 adults aged 25 to 64 years in 2005-2006. Using the International Diabetes Foundation (IDF) cut off point of WC \geq 90 cm for men and \geq 80 cm for women, this study reported a prevalence of abdominal obesity of 48.6%, with a higher prevalence among women (57.1%) than men (40.7%) (MyNCDS 2006).

2.4 Risk of Malnutrition among the Elderly

The NHMS II 1996 included weight and height measurements for 3,286 individuals aged 60 years and above (Fatimah et al. 1997). Approximately half of the older individuals had normal BMI (51.9%). The prevalence of underweight at 29.4% was higher than that for overweight (15.6%) while only 3.1% was obese. In 1999, a study among rural communities in Malaysia found underweight was prevalent among older age group (22.2%) as compared to their younger counterparts (Khor et al. 1999). However, a study in 2007 among rural elderly Malays indicated that overweight (25.0% in men and 24.3% in women) was more prevalent than underweight (13.3%) (Suzana et al. 2007a). This study also found that 8.6% of older men and 14.6% older women were obese.

In 1996, the US National Institute on Aging stated that it was necessary to develop new and non-invasive muscle assessment techniques in order to improve understanding of the relationship between muscle and functional capacity, and calf circumference could be used to assess muscle mass (Rolland et al. 2003; Baumgartner et al. 1998; Chumlea et al. 1995). Calf circumference is a pertinent marker to estimate risk of malnutrition among of older persons. This measure provides valuable information on muscle-related disability and physical function. A cross-sectional study among 267 rural elderly Malays in Kuala Pilah and Sabak Bernam 15.3% men and 7.0% women at high risk of malnutrition using calf circumference (Suzana et al. 2007b).

3. OBJECTIVES

3.1 General Objective

To determine the nutritional status of the Malaysian population aged 18 years and above using anthropometric indicators.

3.2 Specific Objectives

3.2.1 To determine the nutritional status of adults aged 18 years and above using weight, height and waist circumference measurements.

- 3.2.2 To determine the prevalence of peripheral muscle wasting using calf circumference measurement as an indicator for risk of malnutrition in older persons aged 60 years and above.

4. METHODOLOGY

In calculating the sample size, stratification and sampling design, advice was sought from the Methodology Division Department of Statistics Malaysia as well as from several other biostatistics consultants.

4.1 Sampling Design and Sample Size

4.1.1 Sampling frame

The sampling frame for this survey was updated until 2004; an effort undertaken prior to the implementation of Labour Force Survey (LFS) 2004. In general, each selected Enumeration Blocks (EB) comprised of 8 sampled Living Quarters (LQ). The EBs were geographically contiguous areas of land with identifiable boundaries. Each contains about 80-120 LQs with about 600 persons. Generally, all EBs are formed within gazetted boundaries.

The EBs in the sampling frame were also classified by urban and rural areas. The classification into these strata was made up in terms of population of gazetted and built-up areas as follows:

Stratum	Population of gazetted areas and built-up
Metropolitan	75,000 and above
Urban Large	10,000 to 74,999
Urban Small	1,000 to 9,999
Rural	The rest of the country

For sampling purposes, the above broad classification was found to be adequate for all states in Peninsular Malaysia and the Federal Territories of Kuala Lumpur and Labuan. However, for Sabah and Sarawak, due to problems of accessibility, the rural stratum had to be further sub-stratified based on the time taken to reach the area from the nearest urban centre.

For the purpose of urban and rural analysis, Metropolitan and Urban Large strata are combined together thus referred to as 'urban' stratum, while for Urban Small and the various sub-divisions of the rural areas they are combined together to form a 'rural' stratum.

4.1.2 Sample size

The sample size was determined based on 95% Confidence Interval (CI) and the following factors:

a) Expected prevalence rate

The prevalence rate of the health problems for Malaysia obtained from the National Health and Morbidity Survey 2 (NHMS2) were used to estimate the overall sample size. Using the previous finding of 10% prevalence rate, the initial sample size at the state level was calculated in order to come up with overall sample size. The size was further apportioned for each state using the probability proportionate to size (PPS) method.

b) Response rate of the NHMS II

The response rates, which ranged from 83 to 97% for the NHMS2 of each state, were taken into consideration in the course of the determination of sample size.

c) Margin of error and design effect

As the factors of precision and efficient of the survey are paramount, the decision reached for the targeted margin of error is 1.2 and the design effect valued at 2. These values were used at the initial stage of the calculation of the sample size of each state.

The survey findings answering to the specific objectives of this survey are expected to be used for state level programmed planning. Thus, the calculation for the sample size has taken into consideration that the data is to be analyzed at the state level.

In addition to the major factors mentioned earlier, the availability of resources, namely, financial and human resources, and the time taken to conduct this survey also become part of the process of the determination of sample size.

4.1.3 Sample design

A two stage stratified sampling design with proportionate allocation was adopted in this survey. The first stage sampling unit was the EB and within each sampled EB, the LQs were selected as second stage unit.

4.2 Method of Data Collection

4.2.1 Questionnaire

A bi-lingual (Bahasa Malaysia and English) pre-coded questionnaire was designed, pre-tested and piloted prior to the survey.

Overall, the-face-to-face interview (FI) questionnaire was administered to all members of each household. The questionnaire consisted of separate booklets to cater for different age groups of <2,

2-<13, 13-<18 and ≥ 18 years old. For those aged below 13 years, the child's parent or guardian responded on the child's behalf. Those aged 13 years and above were required to answer the respective questionnaires themselves.

Certain terminology and items in the questionnaire were also made available in the dialects or languages of the main ethnic groups in Malaysia, such as Hokkien and Cantonese for the Chinese and Tamil for the Indians. The local dialects of Sabah and Sarawak were also considered. These pronunciations were recorded on tape with an accompanying 'romanised' version of the script. To ensure the accuracy of the translation, all versions were back translated into English by independent reviewers.

4.2.3 The interview

A trained non medical or paramedical interviewer conducted the interview. All qualified adult members from the selected LQs were interviewed face-to-face by trained personnel. Parents or guardians were expected to provide information for their children aged 12 years and below (primary school).

Interviews were commenced from late morning until late evening for each 5-day week. Where an interview was unsuccessful due to the absence of the respondent at the selected LQ, repeated visits were conducted. A household member was only classified as a non-respondent if 3 visits were unsuccessful.

4.3 Field Preparations and Logistic Support

A number of state liaison officers were recruited in preparation for the survey proper. Strong networking with state liaison officers and District Health Officers (MOH and local authorities) from the areas sampled for the survey was established. Field scouts were mobilized from these areas to identify and tag the LQ's selected for the survey, as well as informed to the community and related government agencies of the importance and schedule of the planned survey. State liaison officers were also assisting Field Supervisors in the arrangement of transportation, accommodation and other logistics for the survey teams.

4.3.1 Pilot study

A pilot study was conducted on a sample of EB's (not included in the NHMS III) about 2 months prior to the actual nationwide survey. It was conducted in three different areas in and around the Klang Valley, namely Sepang, Klang and Bangsar. The population in these locations comprised of three distinct socio-demographic strata that are rural, semi-urban and urban respectively. The pilot study focused on the following aspects of the survey:

- a) Testing of the questionnaire
- b) Testing of the field logistic preparation
- c) Testing of the scouting activities
- d) Testing of the central monitoring and logistic support

4.3.2 Training of data collection teams

A training period of 2 weeks for field supervisors, team leaders, nurses and interviewers were held to

familiarize them with the questionnaire, developed their interpersonal communication skills and appreciate the need for a good teamwork. Briefing on the questionnaire, mock interview in the classroom and individual practice under supervision was conducted during the training.

4.4 Quality Control

Quality control procedures for field data collection were done in two stages, at the field and central levels.

4.5 Data Management

4.5.1 Data screening

The following data screening exercises had been conducted at field and central levels prior to data entry:

- a) Field data screening by each interviewer at the end of his/her interview
- b) Field data screening of each question by peer interviewers through exchanging questionnaire booklets
- c) Field data screening by team leaders and field supervisors
- d) Central data screening of the questionnaire variables by the quality control team.

4.5.2 Data entry

The data entry system was developed to record the information collected during the data collection phase. It is a web based system that allows multiple simultaneous accesses to the database. The NHMS III used a double manual data entry method and any discrepancy between both entries was verified by the supervisors. The data entry started simultaneously with data collection (first week of April 2006) and was completed at the end of January 2007. The data entered was stored in the database according to the module. The databases were designed using Structured Query Language (SQL) which is a standard language for relational database management system.

4.5.3 Data Analysis

Preliminary analysis was carried out on cleaned sample data sets to enhance quality control and refinement of the computer analysis programmes. Upon completion of data entry and cleaning, full analysis were carried out. The analysis was carried out towards computing expected outcomes of each research topic.

Analysis of the data was conducted using STATA and SPSS 15.0. All analyses took into account the complex survey design and unequal selections of NHMS III. Findings are reported as the weighted estimates of the prevalence (mean value, confidence interval and standard error of the mean). Prior to analysis, the data was examined for quality. Appendix 4 presents the quality report for data on the adult.

4.6 Anthropometric Measurements

Anthropometric measurements comprising body weight, height or half arm span (for older persons aged 60 years and above) and waist circumference were performed on respondents aged 18 years and above. In addition to these measurements, calf circumference was also measured in older persons (Appendix 1: Table 1). Trained data collectors carried out these measurements based on a standard procedure in the technical manual of NHMS III. For details of the procedure of measurements, please refer to the Technical Manual of Anthropometric Measurements, NHMS III (Institute for Public Health 2006). Body weight, standing height and waist circumference measurements were carried out according to the World Health Organization (WHO) protocol (WHO 1998). Meanwhile the half arm span and calf circumference measurements were based on the National Health and Nutrition Examination Survey (NHANES) guidelines (NHAHES 2002).

Body weight was measured in light indoor clothing without shoes to the nearest 0.1 kilogram using a Tanita digital lithium weighing scale (Tanita 318, Japan). Height was measured without shoes to the nearest 0.1 centimeter using a SECA portable body meter (SECA 206, Germany). For elderly subjects aged 60 years and above who cannot stand upright or had kyphosis, half arm span was measured to the nearest 0.1cm, using a SECA measuring tape (SECA, Germany). Standing height of these subjects was then estimated based on the arm span measurements using a predictive equation (Suzana & Ng 2003).

Waist circumference was measured at the midpoint between the inferior margin of the last rib and the crest of the ilium, to the nearest 0.1 centimeter using a SECA measuring tape (SECA, Germany). Calf circumference measurements were done horizontally around the calf and moved up and down to locate the maximum circumference using a SECA measuring tape (SECA, Germany) to the nearest 0.1 centimeter. All measurements were taken twice and the average value was used for data analysis (Appendix 1: Table 1).

A study on reliability and validity of all anthropometric measurements was done prior to the survey in order to determine the precision of the instruments and measurements (Appendix 3 and Appendix 4).

Based on the weight and height measurements, body mass index (BMI) was computed as weight in kilograms divided by the square of the height in meters (kg/m^2). The BMI classification recommended by the World Health Organization Expert Committee on Physical Status was used to determine the nutritional status of the adults (Appendix 1: Table 2) (WHO 1995). In order to assess the abdominal obesity, the waist circumference (WC) cut-off point recommended by the World Health Organization was used (Appendix 1: Table 2) (WHO 1998). Meanwhile the calf circumference (CC) cut-off points used in this survey was based on the Malaysian cut-off points (Sakinah et al. 2004).

5. FINDINGS

The Third National Health and Morbidity Survey (NHMS III) included nutritional assessment of 33,465 eligible individuals 18 years and above from all states and the federal territories in Malaysia. As part of nutritional assessment, body mass index (BMI) was obtained among 33,055 individuals age 18 years and above using weight and height measurements. In addition, data for waist circumference (WC) among 32,900 individuals was analysed for risk of abdominal obesity. Data of 4,309 individuals aged 60 years

and above was used to obtain peripheral muscle wasting. Ethnically, the individuals are classified as Malay, Chinese, Indian, Other Bumis and Others, while age was categorised into fourteen (14) groups.

The findings for the prevalence of normal weight, underweight, overweight and obese by socio-demographic characteristics are shown in Appendix 1 (Table 3 to Table 9). In addition to that, the figures to indicate the variability of the measured parameters are shown in Appendix 2 (Figure 1 to Figure 24).

5.1 Prevalence of Adults with Normal Body Mass Index

The national prevalence of adults aged 18 years and above with normal body weight based on body mass index (BMI) was 48.4% (CI: 47.7 - 49.0) (Appendix 1: Table 3).

5.1.1 Prevalence by state

The state of Perlis had the lowest percentage of adults with normal BMI [40.1% (CI: 34.3 - 46.2)] followed by Malacca [43.4% (CI: 39.7 - 47.3)]. Sabah had the highest prevalence of normal BMI adults [54.8% (CI: 53.0 - 56.6)]. Besides Sabah, two other states namely, Sarawak [51.4% (CI: 49.4 - 53.4)] and Perak [50.8% (CI: 48.6 - 52.9)], as well as the WP Kuala Lumpur [50.4% (CI: 47.8 - 53.0)] had more than 50.0% of their adults with normal BMI.

5.1.2 Prevalence by urban-rural strata

The prevalence of adults with normal BMI in urban areas [48.4% (CI: 47.5 - 49.2)] was similar as that in rural areas [48.4% (CI: 47.4 - 49.4)].

5.1.3 Prevalence by gender

There was a higher prevalence of normal BMI among the men [52.0% (CI: 51.2 - 52.9)] compared to the women [45.3% (CI: 44.5 - 46.1)].

5.1.4 Prevalence by ethnicity

The prevalence of adults with normal BMI was lowest among Indians [41.4% (CI: 39.4 - 43.5)] followed by Malays [45.1% (CI: 44.3 - 45.9)], Other Bumis [52.0% (CI: 50.2 - 53.9)], Chinese [54.4% (CI: 53.2 - 55.7)] and Others [62.5% (CI: 59.8 - 65.2)].

5.1.5 Prevalence by age

Overall, the proportion of adults with normal BMI status ranged from 39.7% to 57.7% depending on the age group. The oldest (≥ 80 years) and the age groups of 18-19 years and 20-24 years had higher prevalence of normal BMI at 57.2% (CI: 51.6 - 62.5), 57.7% (CI: 55.2 - 60.1) and 58.9% (CI: 57.3 - 60.6) respectively than the other age groups.

The age group with the lowest prevalence of normal BMI was 50-54 years [39.7% (CI: 38.0 - 41.6)]

followed by the age group of 55-59 years [40.9% (CI: 38.9 - 42.9)] and the 45-49 years group [40.9% (CI: 39.2 - 42.6)].

5.1.6 Prevalence by marital status

Adults who were not married had the highest prevalence of normal BMI 57.8% (CI: 56.5 - 59.1), compared to married adults with a prevalence of 46.0% (CI: 45.3 - 46.7). The categories of divorcees and widow/widower also had lower prevalence [48.8% (CI: 45.1 - 52.5)] than the unmarried category [41.9% (CI: 39.6 - 44.3)].

5.1.7 Prevalence by educational level

The prevalence of normal BMI was rather similar among adults with different education levels. Those with no formal schooling or primary schooling showed respectively prevalence of 48.8% (CI: 47.0 - 50.6) and 46.6% (CI: 45.5 - 47.6) with normal BMI. Meanwhile the prevalence with normal BMI for those with secondary or tertiary education was 48.6% (CI: 47.8 - 49.5) and 51.1% (CI: 49.3 - 53.0) respectively.

5.1.8 Prevalence by household monthly income level

Comparison across the income groups showed that adults in the lowest (less than RM400) and highest (RM5000 and above) monthly income categories had the highest prevalence of normal BMI, at 51.8% (CI: 49.8 - 53.7) and 51.9% (CI: 49.1 - 54.6) respectively. Between these income categories, the prevalence of normal BMI decreased with income, from 49.9% (CI: 48.3 - 51.5) for the RM400 - RM699 group to 46.6% (CI: 43.5 - 49.6) for the RM4000 - RM4999 group.

5.1.9 Prevalence by job category

There appears to be a general trend for the more physically active occupations to show a higher prevalence of normal BMI. The Senior Official and Manager category had the lowest prevalence of normal BMI at 44.1% (CI: 40.2 - 48.2). On the other hand, categories involving more physical activity such as Skilled Agriculture and Fishery, Craft and Related Trade Workers and Elementary Occupations had higher prevalence of normal BMI. In comparison, the Housewife category showed the lowest at 40.7% (CI: 39.4 - 41.9).

5.2 Prevalence of Underweight

The findings for the prevalence of underweight by socio-demographic characteristics are shown in Appendix 1 (Table 4). The overall prevalence of underweight adults was 8.5% (CI: 8.2 - 8.9).

5.2.1 Prevalence by state

The state of Kelantan had the highest prevalence of underweight adults [10.9% (CI: 9.3 - 12.7)] followed by Terengganu [10.8% (CI: 9.3 - 12.6)], Sabah [10.6% (CI: 9.4 - 11.9)] and Perlis [10.5% (CI: 7.8 - 14.1)]. In contrast, Selangor had the lowest prevalence of underweight [6.6% (CI: 6.0 - 7.4)] followed by the WP Kuala Lumpur [7.4% (CI: 6.0 - 9.0)], Malacca [8.1% (CI: 6.2 - 10.5)] and the WP Labuan [8.1% (CI: 5.6 - 11.6)].

5.2.2 Prevalence by urban-rural strata

Adults in rural areas had a higher prevalence of underweight [9.8% (CI: 9.2 - 10.4)] compared to adults in urban areas [7.8% (CI: 7.4 - 8.3)].

5.2.3 Prevalence by gender

Men and women had almost similar underweight prevalence [8.3% (CI: 7.8 - 8.8)] and [8.7% (CI: 8.3 - 9.2)] respectively.

5.2.4 Prevalence by ethnicity

Other Bumis adults had the highest underweight prevalence [9.5% (CI: 8.4 - 10.7)] while Indians had the lowest underweight prevalence [7.6% (CI: 6.6 - 8.8)]. Malay and Chinese subjects had almost similar prevalence for underweight [8.5% (CI: 8.0 - 9.0)] and [8.4% (CI: 7.7 - 9.2)] respectively.

5.2.5 Prevalence by age

The younger and older age groups showed higher underweight prevalence than the other age groups. Those aged 18-19 years had an underweight prevalence of 24.6% (CI: 22.5 - 26.8) while the ≥ 80 years age group had a prevalence of 26.3% (CI: 21.9 - 31.2). The lowest prevalence of underweight was for the age groups of 45-44 years and 45-49 years.

5.2.6 Prevalence by marital status

Married adults had a lower underweight prevalence than those not married, divorcees and widows/widowers. The underweight prevalence for the married was 5.6% (5.3 - 6.0) compared to 17.1% (CI: 16.2 - 18.2) for the unmarried subjects.

5.2.7 Prevalence by educational level

Education background did not show a clear correlation with underweight status. On the one hand, those with no education had the highest underweight prevalence [11.8% (CI: 10.7 - 12.9)], however those with primary schooling showed the lowest prevalence at 6.3% (CI: 5.8 - 6.9). Meanwhile subjects with tertiary and secondary education had almost similar prevalence, [8.0% (CI: 7.1 - 9.1)] and [9.2% (CI: 8.7 - 9.7)] respectively. Thus, underweight prevalence appeared to be independent of subjects' educational attainment.

5.2.8 Prevalence by household monthly income level

Income level showed a clear trend with regard to underweight status. As household monthly income level increased, the underweight prevalence decreased. Households earning less than RM400 per month had the highest underweight prevalence of 11.9% (CI: 10.7 - 13.3). On the other hand, those in the RM5000 and above category had the lowest underweight prevalence of 6.4% (CI: 5.5 - 7.5).

5.2.9 Prevalence by job category

Unemployed subjects showed the highest underweight prevalence of 15.3% (CI: 14.1 - 16.6) followed by the Craft and Related Trade Workers [10.1% (CI: 8.7 - 11.7)] and Clerical Workers [10.1% (CI: 8.8 - 11.5)]. The lowest prevalence of underweight was among the Senior Official and Manager group [2.4% (CI: 1.5 - 4.0)].

5.3 Prevalence of Overweight

The findings for the prevalence of overweight by socio-demographic characteristics are shown in Appendix 1 (Table 5). The overall national prevalence of overweight was 29.1% (CI: 28.6 - 29.7).

5.3.1 Prevalence by state

Perlis had the highest overweight prevalence [32.1% (CI: 26.5 - 38.4)] followed by Malacca [31.1% (CI: 27.3 - 35.0)] and Kedah [31.1% (CI: 29.2 - 33.0)]. Other states with more than 30% overweight prevalence were Selangor and the WP Labuan. The state with the lowest prevalence for overweight was Sabah [24.9% (CI: 23.4 - 26.6)] followed by Perak [27.6% (CI: 25.7 - 29.6)].

5.3.2 Prevalence by urban-rural strata

The difference in overweight prevalence was small between the urban and rural areas, that is, 29.7% (CI: 29.0 - 30.4) and 28.1% (CI: 27.3 - 28.9) respectively.

5.3.3 Prevalence by gender

The overweight prevalence was small between the sexes, with 29.7% (CI: 28.9 - 30.5) for the male and 28.6% (CI: 27.9 - 29.3) for the female adults.

5.3.4 Prevalence by ethnicity

Indian adults had the highest prevalence of overweight, [33.2% (CI: 31.4 - 35.1)] followed by Malays [29.8% (CI: 29.1 - 30.5)] and Chinese [28.5% (CI: 27.3 - 29.6)]. The prevalence of overweight among Other Bumis and Others were 27.3% (CI: 25.6 - 29.1) and 20.8% (CI: 18.8 - 23.0) respectively.

5.3.5 Prevalence by age

The younger age groups of 18-19 years and 20-24 years, as well as the oldest ≥ 80 years had comparatively lower overweight prevalence than the other age groups. The prevalence for 18-19 years and 20-24 years were respectively 11.1% (CI: 9.7 - 12.6) and 13.8% (CI: 12.6 - 15.0), while that for the ≥ 80 years was 12.6% (CI: 9.4 - 16.8).

The age groups of 50-54 years and 55-59 years showed the highest prevalence of overweight at 38.0% (CI: 36.2 - 39.7) and 37.8% (CI: 35.8 - 39.8) respectively. Overweight prevalence exceeded 30% in the subjects aged 35 years till 69 years.

5.3.6 Prevalence by marital status

Married subjects and widows/widowers had the highest overweight prevalence at 32.9% (CI: 32.3 - 33.6) and 32.6% (CI: 30.5 - 34.8) respectively. Unmarried subjects had the lowest overweight prevalence [16.1% (CI: 15.2 - 17.0)].

5.3.7 Prevalence by educational level

There was a relatively small difference in the overweight prevalence according to education attainment. The prevalence value ranged from 27.7% (CI: 26.1 - 29.3) for the category with no schooling to 28.0% (CI: 27.3 - 28.8) for those with secondary education, 29.0% (CI: 27.4 - 30.7) for the tertiary education category, and 31.7% (CI: 30.7 - 32.7) for the primary education group.

5.3.8 Prevalence by household monthly income level

There was an upward trend in overweight prevalence with increasing household monthly income level. At the lower household monthly income levels of less than RM400 and RM400-RM699, the prevalence was 24.8% (CI: 23.1 - 26.6) and 26.3% (CI: 24.9 - 27.7) respectively. The prevalence of overweight exceeded 30% for household monthly income levels exceeding RM1000, peaking at RM4000-4999 [31.9% (CI: 29.3 - 34.6)].

5.3.9 Prevalence by job category

Overweight prevalence was highest for the Senior Official and Manager category [37.4% (CI: 33.5 - 41.4)] followed by the Technical and Associate category [34.4% (CI: 32.5 - 36.4)]. Housewife as a group also showed a high overweight prevalence of 32.8% (CI: 31.7 - 33.9). Other occupation groups with more than 30% overweight prevalence include the Professional [32.2% (CI: 30.2 - 34.3)] and the Plant & Machine Operator & Assembler category [30.5% (CI: 28.4 - 32.7)].

5.4 Prevalence of Obesity

The findings for the prevalence of obesity by socio-demographic characteristics are shown in Appendix 1 (Table 6). The prevalence of obesity classifications is also shown in Appendix 1 (Table 7 to Table 9)

5.4.1 Prevalence by state

Overall, the national prevalence of obesity was 14.0% (CI: 13.6 - 14.5). The state of Negeri Sembilan had the highest obesity prevalence [18.6% (CI: 16.0 - 21.4)] followed by Malacca [17.4% (CI: 14.4 - 21.0)] and Perlis [17.2% (CI: 12.6 - 23.2)]. In contrast, Sabah had the lowest prevalence of obesity [9.7% (CI: 8.7 - 10.8)]. Sarawak and the WP Kuala Lumpur also had relatively lower prevalence levels at 11.5% (CI: 10.2 - 12.9) and 12.5% (CI: 10.7 - 14.4) respectively.

5.4.2 Prevalence by urban-rural strata

The obesity prevalence for urban and rural areas did not differ much at 14.2% (CI: 13.6 - 14.8) and 13.7% (CI: 13.0 - 14.4) respectively.

5.4.3 Prevalence by gender

The obesity prevalence is noticeably higher for women [17.4% (CI: 16.7 - 18.0)] than the men [10.0% (CI: 9.5 - 10.5)].

5.4.4 Prevalence by ethnicity

Indian adults had the highest obesity prevalence [17.7% (CI: 16.3 - 19.3)] followed by Malays [16.6% (CI: 16.0 - 17.3)] and Other Bumis [11.2% (CI: 10.1 - 12.3)]. Chinese and the Others had comparatively lower prevalence levels respectively at 8.7% (CI: 8.0 - 9.4) and 8.1% (CI: 6.7 - 9.7). It is noted that the obesity prevalence for Indians and Malays were doubled that for Chinese and the Others group.

5.4.5 Prevalence by age

Generally, the obesity prevalence showed an 'inverted U' pattern, commencing with the youngest age group (18-19 years) having the lowest prevalence, and thereafter, the obesity prevalence increased with age peaking at 45-49 years before declining to the lowest prevalence level in the oldest age group (≥ 80 years).

The age group of ≥ 80 years has the lowest obesity prevalence [3.9% (CI: 2.2 - 6.8)] followed by the group aged 18-19 years [6.7% (CI: 5.5 - 8.1)]. The highest obesity prevalence was seen among adults aged 45-49 years [19.3% (CI: 18.0 - 20.7)] followed by the 50-54 age group at 18.7% (CI: 17.3 - 20.1).

5.4.6 Prevalence by marital status

Married subjects, widows/widowers and divorcees were among those with high prevalence of obesity at 15.4% (CI: 14.9 - 16.0), 15.2% (CI: 13.6 - 17.0) and 15.2% (CI: 12.6 - 18.2) respectively. Unmarried subjects had the lowest obesity prevalence of 9.0% (CI: 8.3 - 9.8).

5.4.7 Prevalence by educational level

There was no clear trend for obesity prevalence according to education level. Both the categories of No Schooling and Tertiary Education had similar obesity prevalence levels of 11.7% (CI: 10.7 - 12.9) and 11.8% (CI: 10.7 - 13.1) respectively. Meanwhile, those with Primary and Secondary Education had comparatively higher obesity prevalence at 15.5% (CI: 14.7 - 16.2) and 14.2% (CI: 13.6 - 14.8) respectively.

5.4.8 Prevalence by household monthly income level

Household monthly income at the lowest level (less than RM400) and the highest level (RM5000 and above) had the lowest obesity prevalence at 11.5% (CI: 10.3 - 12.8) and 11.4% (CI: 9.6 - 13.4) respectively. Subjects earning between RM700 and RM4999 per month were among those with relatively higher obesity prevalence, exceeding 14.0% in each category.

5.4.9 Prevalence by job category

Obesity prevalence was markedly higher for the Housewife group than the other occupation categories at 20.3% (CI: 19.4 - 21.3). The next higher prevalence was in the Senior Officials and Manager category

at 16.1% (CI: 13.3 - 19.3). The lowest obesity prevalence was in the Skilled Agriculture & Fishery category with 8.35 (CI: 7.2 - 9.5), followed by the Elementary Occupation [9.9% (CI: 8.5 - 11.6)] and Unemployed categories [9.9% (CI: 8.9 - 11.0)].

5.5 Prevalence of Abdominal Obesity

The findings for the prevalence of abdominal obesity as assessed by waist circumference by socio-demographic characteristics are shown in Appendix 1 (Table 10). The overall national prevalence of abdominal obesity was 17.4% (CI: 16.9 – 17.9).

5.5.1 Prevalence by age group

The prevalence of abdominal obesity increased steadily with age until the age of 55 to 59 years, after which the prevalence declined. It is noted that more than half of the individuals aged 45 years to 59 years old had abdominal obesity.

5.5.2 Prevalence by gender

The prevalence of abdominal obesity among the men at 7.3% (CI: 6.7 – 7.6) was higher than that for the women of 26.0% (CI: 25.2 – 26.8). It is estimated that half of adult women in Malaysia (1,741,706 persons) had abdominal obesity.

5.5.3 Prevalence by ethnicity

According to ethnicity, the prevalence of abdominal obesity was highest among Indians at 28.2% (CI: 26.3 – 30.1), followed by Malays [18.6% (CI: 17.9 – 19.2)], Chinese [14.1% (CI: 13.2 – 15.1)], Other Bumis [12.7% (CI: 11.6 – 14.0)] and Others [9.9% (CI: 8.4 – 11.7)].

5.5.4 Prevalence by strata

The prevalence of abdominal obesity was higher among urban adults [17.9% (CI: 17.3 – 18.6)] than rural adults [16.4% (CI: 15.6 – 17.2)].

5.5.5 Prevalence by household monthly income level

The prevalence of abdominal obesity increased with income categories from 17.2% (CI: 15.7 – 18.8) for individuals with household monthly income less than RM400 to 18.4% (CI: 17.2 – 19.6) for those with household income of RM2000 - < RM3000 per month.

5.5.6 Prevalence by occupation

The prevalence of abdominal obesity was highest among Housewives at 31.3% (CI: 30.2 – 32.4) followed by the Unemployed category [17.3% (CI: 15.9 – 18.7)]. The prevalence ranged from 8.9% to 15.8% for the other job categories.

5.5.7 Prevalence by states

According to states, the prevalence of abdominal obesity was highest for Perlis at 27.4% (CI: 22.0 – 33.4), followed by Selangor [21.7% (CI: 20.4 – 23.0)] and Pulau Pinang [20.4% (CI: 18.3 – 22.7)]. Johor, Pahang and Kedah had almost similar prevalence of approximately 17%

5.5.8 Prevalence by marital status

The prevalence of abdominal obesity was highest for the Widow/widower group at 31.7% (CI: 29.5 – 34.0), followed by Divorcee [20.6% (CI: 17.7 – 23.9)] and Married [19.2% (CI: 18.7 – 19.8)] group.

5.5.9 Prevalence by educational level

According to the educational level, the prevalence of abdominal obesity was highest among individuals who had not received formal education at 23.7% (CI: 22.2 – 25.2), followed by those with primary education [21.2% (CI: 20.3 – 22.1)]. The prevalence was below 20.0% for other educational levels.

5.6 Prevalence of Peripheral Muscle Wasting

The findings for the prevalence of peripheral muscle wasting, indicating risk of malnutrition as assessed using calf circumference, according to socio-demographic characteristics among individuals aged 60 years and above are shown in Appendix 1 (Table 11).

The overall national prevalence of peripheral muscle wasting was 19.9% (CI: 18.5 - 21.6). It is estimated that 316,310 of individuals aged 60 years and above was at high risk of malnutrition based on the calf circumference measurement.

5.6.1 Prevalence by age group

The prevalence of peripheral muscle wasting increased steadily with age. It is noted that individuals aged 80 years and above [37.9% (CI: 32.5 – 43.7)] was twice likely to be at risk of malnutrition compared to the group aged 60-64 years [14.1% (CI: 12.2 – 16.3)].

5.6.2 Prevalence by gender

The prevalence of peripheral muscle wasting among men at 23.7% (CI: 21.7 – 25.9) was higher than women at 16.8% (CI: 15.1 - 18.5).

5.6.3 Prevalence by ethnicity

The prevalence of peripheral muscle wasting was highest among Others at 25.7% (CI: 16.0 - 38.5), followed by Indians [23.7% (CI: 18.5 - 29.9)], Malays [21.2% (CI: 19.2 - 23.5)] and Chinese [16.7% (CI: 14.4 - 19.4)].

5.6.4 Prevalence by strata

The prevalence of peripheral muscle wasting was higher among rural older adults [22.9% (CI: 20.6 - 25.2)] as compared to the urban older adults [17.7% (CI: 15.6 - 19.9)].

5.6.5 Prevalence by socioeconomic status

The prevalence of peripheral muscle wasting decreased with household income. The highest prevalence was noted among individuals with household monthly income less than RM400, and RM400 to less than RM700 at 22.6% (CI: 19.7 - 25.7) and 21.1% (CI: 18.3 - 24.3) respectively.

5.6.6 Prevalence by marital status

The prevalence of peripheral muscle wasting was highest among Divorcees and Not Married individuals at 29.5% (CI: 23.5 - 36.4) and 24.3% (CI: 15.7 - 35.5) respectively.

5.6.7 Prevalence by educational level

The prevalence of peripheral muscle wasting declined with educational level. Older individuals with no education had the highest rate of peripheral muscle wasting at 22.1% (CI: 19.9 - 24.2), followed by the primary education group at 20.1% (CI: 18.1 - 22.2). The prevalence of peripheral muscle wasting was below 15.0% for those who had received secondary and tertiary education.

5.7 Mean Body Mass Index (BMI)

The mean BMI by socio-demographic characteristic are shown in Appendix 1 (Table 12).

5.7.1 Mean BMI by state

The states which had mean BMI higher than the national average were Selangor [25.6 kg/m² (CI: 25.3 - 25.9)], Negeri Sembilan [25.5 kg/m² (CI: 25.1 - 25.9)], Melaka [25.5 kg/m² (CI: 24.9 - 26.0)], Perlis [25.3 kg/m² (CI: 24.4 - 26.3)], Kedah [25.3 kg/m² (CI: 24.9 - 25.7)], Pahang [25.2 kg/m² (CI: 24.6 - 25.8)], the WP Labuan [25.3 kg/m² (CI: 24.4 - 26.2)] and Johor [25.0 kg/m² (CI: 24.7 - 25.3)]. Terengganu [24.9 kg/m² (CI: 24.5 - 25.3)], Perak [24.8 kg/m² (CI: 24.4 - 25.2)], WP Kuala Lumpur [24.8 kg/m² (CI: 24.4 - 25.1)], Pulau Pinang [24.7 kg/m² (CI: 24.4 - 25.0)], Kelantan [24.6 kg/m² (CI: 24.0 - 25.2)], Sarawak [24.6 kg/m² (CI: 24.3 - 24.9)] and Sabah [24.2 kg/m² (CI: 23.7 - 24.6)] had mean BMI lower than the national mean value.

5.7.2 Mean BMI by urban-rural strata

The mean BMI was slightly higher in the urban population [25.1 kg/m² (CI: 25.0 - 25.3)] compared to urban population [24.8 kg/m² (CI: 24.6 - 25.0)].

5.7.3 Mean BMI by gender

Comparison by gender showed that mean BMI for women [25.4 kg/m² (CI: 25.2 - 25.5)] was higher than that for men [24.6 kg/m² (CI: 24.4 - 24.7)].

5.7.4 Mean BMI by ethnicity

Among the ethnic groups, Indians had the highest mean BMI [25.8 kg/m² (CI: 25.5 - 26.1)], followed by Malays [25.4 kg/m² (CI: 25.2 - 25.6)] and Chinese [24.2 kg/m² (CI: 24.1 - 24.4)]. Meanwhile, the mean BMI for Other Bumis was 24.5 kg/m² (CI: 24.1 - 24.9) and for the Others group was 23.7 kg/m² (CI: 23.2 - 24.1).

5.7.5 Mean BMI by age

The mean BMI increased with age, peaking for the 50 – 54 age group at [26.5 kg/m² (CI: 26.1 - 26.8)], and declining after that. The lowest mean BMI was among the elderly group ≥ 80 years at 22.0% (CI: 20.9 – 23.1).

5.7.6 Mean BMI by marital status

The mean BMI was lowest among the Single group [23.2 kg/m² (CI: 22.9 - 23.5)] compared to other marital status groups. It is noted the Married group had the highest mean BMI [25.6 kg/m² (CI: 25.4 - 25.7)] followed by Widow/widower [25.2 kg/m² (CI: 24.8 - 25.5)] and Divorcee group [24.7 kg/m² (CI: 24.2 - 25.3)].

5.7.7 Mean BMI by educational level

Comparison by level of education showed that the group with no education had the lowest mean BMI [24.4 kg/m² (CI: 24.2 - 24.7)], while the highest mean BMI was in the primary education group [25.4 kg/m² (CI: 25.2 - 25.6)].

5.7.8 Mean BMI by household monthly income level

The mean BMI increased with household monthly income, being lowest in households earning less than RM400 monthly [24.3 kg/m² (CI: 23.7 - 24.9)] and highest in the RM4000-4999 group [25.2 kg/m² (CI: 24.8 - 25.7)].

5.7.9 Mean BMI by job category

The Senior Official & Manager and Housewife categories had higher mean BMI compared to other job categories. The mean BMI for Senior Official & Manager and Housewife were 26.6 kg/m² (CI: 25.0 - 28.2) and 26.1 kg/m² (CI: 25.9 - 26.3) respectively. Meanwhile, the Skilled Agricultural & Fishery, and Elementary Occupation categories had the lowest mean BMI at 24.0 kg/m² (CI: 23.7 - 24.3) and 24.0 kg/m² (CI: 23.5 - 24.5) respectively.

5.8 Mean Waist Circumference (WC)

Result of this study showed that male adults had mean WC [84.0cm (CI: 83.8 - 84.3)] that was higher than that for female adults [80.3cm (CI: 80.1 - 80.6)].

5.9 Mean Calf Circumference (CC)

Comparison by sex showed that the mean CC for male adults [33.1cm (CI: 32.8 - 33.3)] was higher than that for female adults [31.6cm (CI: 31.4 - 31.8)].

6. DISCUSSION

This study is the third of a national investigation on the health and morbidity of the Malaysian population, conducted every ten years beginning with the NHMS I in 1986. The inclusion of a nutritional status component in the form of BMI was reported in the NHMS II in 1996. In the present 2006 NMHS III, the nutritional status component was expanded to include a number of key indicators.

The NHMS III found that the national prevalence of adults with normal BMI was 48.4%. This means that less than half of the individuals aged 18 years and above in Malaysia had normal BMI. This finding was similar to the result of the Malaysian Adult Nutrition Survey, 2003, which reported that 49.3% had normal BMI (MANS 2003).

The nutritional problems identified in the NHMS III included underweight, overweight, obesity and abdominal obesity in Malaysian adults. The national prevalence of underweight found was 8.5%, three times lower than that reported in NHMS II (25.2%). A further breakdown by strata found a similar reduction in underweight prevalence by threefold; in urban areas from 23.6% (NHMS II) to 7.8% (NHMS III) and in rural areas from 27.2 % to 9.8%. The latter was lower than that reported for rural areas in the 1990s (12.4%) (Ismail et al. 1995). The finding of a lower proportion of adults with chronic energy deficiency over the past decade is encouraging, probably reflecting improvement in economic status and food intake in general.

Over the same period however, the prevalence of overweight has increased to 28.6% from 16.6% in the NHMS II. Similarly, the prevalence of obesity was higher (14.2%) compared to that in 1996 (4.4%) (Fatimah et al. 1997). The latest finding is confirmed by the MANS, which found 12.2% obesity and 26.7% overweight prevalence (MANS 2003). It is alarming to note that the obesity rate has tripled over the last decade.

An important finding is that overweight and obesity prevalence were quite similar in urban and rural areas. The prevalence of overweight in urban and rural areas were 29.6% and 28.3% respectively, while the corresponding figures for obesity were 14.3% and 13.9%. The factors involved in leading to overweight and obesity problem could be different for the different types of locations. Studies are needed to unravel these factors, which may have socio-economic, cultural, and technological implications.

In this context, sex differences in obesity also deserve attention. In the NHMS II, women showed significantly higher prevalence of overweight and obesity than men (17.9% versus 14.4%, 5.7% versus 2.9% respectively) (Fatimah et al. 1997). In this survey however, sex difference for overweight prevalence was no longer significant, but for obesity, women were at a noticeably higher prevalence (17.5%) than men (10.2%).

Another marked factor in the comparison of prevalence of overweight and obesity is ethnicity. Indians and Malays had higher overweight and obesity prevalence than Chinese and other ethnic groups, a finding that is similar to that in NHMS II.

Globally, it is estimated that 1.2 billion people are overweight and at least 300 million of them are obese (James 2004). In the United States, the prevalence of obesity in adults has increased from 14.6% (NHES, 1960-62) to 22.5% (NHANES III, 1988-1994) and 30.4% (1999-2000) (Wright et al. 2002). Obesity rate was found at 6% in Singapore (18-69 years; 1998) (James 2004); 2.2% and 3.5% for men and women respectively in China (30 years and above, 2000) (Jia et al. 2002), and in Thailand, 26.1% (BMI \geq 25 kg/m², 20 years and above, 1995) (Kantachuvesiri 2005). In comparison, Malaysia appears to have one of the highest prevalence of obesity among South-East Asian countries. Coincident with increasing rates of obesity, the prevalence of associated diseases has also escalated, including cardiovascular diseases, diabetes, hypertension and liver disease. The public health implication arising from this finding is serious and calls for immediate action by all stakeholders.

Recent studies indicated that abdominal obesity is more strongly associated with obesity-related health problems than is overweight measured by BMI. The national prevalence of abdominal obesity using waist circumference (>102 cm for men and > 88 cm for women) was 17.4%, with women at a higher risk (25.9%) compared to men (7.2%).

The Malaysian NCD surveillance 2005/2006 (MyNCDs-1) also reported a high prevalence of abdominal obesity among 2572 adults aged 25 to 64 years using waist circumference (>90cm for men and >80 cm for women) at 48.6%, with more women (57.1%) than men (40.7%) having this condition (MyNCDs 2006). Using a similar cut-off point for waist circumference as MyNCDs-1, the prevalence of abdominal obesity among 1400 adults aged 20 to 64 years in Sri Lanka was 34.9% (Arambepola 2007). Similar sex differences in the prevalence of abdominal obesity have also been observed in other countries such as Sri Lanka (Arambepola 2007) and countries in the IDEA study (Bassand 2006). The current NHMS III finding for abdominal obesity was higher than the figure reported by the IDEA study for Southeast Asia (6.0% men and 22.0% women) and East Asia (6.0% men and 22.0% women) but lower than that for South Asia (20.0% men and 55.0% women) and Northwest Europe (31.0% men and 43.0% women) (Bassand 2006).

In the NHMS III study, it was found that the risk of abdominal obesity was higher among Indians, unemployed individuals, housewives, widow or widower and those from lower educational level. The high prevalence among Indians is consistent with the findings from the IDEA study that South Asia (India and Pakistan) had a remarkably high prevalence of abdominal obesity than other Asian regions but comparable with those in the Europe (Bassand 2006). This finding suggests that the genetics might be a prominent predictor of abdominal obesity among Indians but this does not exclude environmental factors, including behavioral and cultural influences on food preparation and consumption. Studies should be carried out to identify the environmental and behavioural factors associated with increasing abdominal obesity among Malaysian adults.

The use of BMI alone is not sufficient to assess nutritional status in older people, as malnutrition evidenced by sarcopenia or low muscle mass can be present in elderly people with a normal BMI (Baumgartner et al. 1998). A recent study among rural elderly Malays indicated that 68.4% of subjects with normal BMI had been categorized into mild to severe malnutrition clinically using the Subjective Global Assessment (Suzana et al. 2007a).

In the NHMS III survey, calf circumference, a physiological marker of lower limb peripheral muscle wasting was used as an indicator of malnutrition risk among the older persons. By this indicator, approximately a quarter of individuals aged 60 years and above was found malnourished, with men at a greater risk. Peripheral muscle wasting using calf circumference was also reported to be affecting a quarter of hospitalized geriatric patients admitted to University of Malaya Medical Center (Sakinah et al. 2004), but the prevalence among elderly people in the rural communities was lower (Suzana et al. 2007b). In the present NHMS III survey, the risk of malnutrition as assessed by low calf circumference increased with age and was more pronounced among individuals from lower socioeconomic status (i.e. lower household income and education level) and rural areas, and also among divorcees and not married individuals. There were slight differences among the ethnic groups, with Others, Indians and Malays showing higher prevalence than Chinese and Other Bumis. The finding of higher prevalence of peripheral muscle wasting among men than women in the present NHMS III study was also reported in previous studies (Suzana et al. 2007a; Sakinah et al. 2004).

Based on the findings of this survey, it is projected that the prevalence of overweight and obese among Malaysian adults is likely to increase in the next decade. There is thus a potential increase in the prevalence of non-communicable diseases in the country. These problems have serious implications on the economic burden of obesity and health care in the country. Obesity is also associated with an increased prevalence of socioeconomic hardship due to a higher rate of disability, early retirement and widespread of the diseases. Therefore, it is crucial for health care providers, programme managers and policy makers to revise the public health policy and to strengthen intervention programmes for improvement of health and nutritional status of the Malaysian population.

The problem of underweight among Malaysian adults and risk of malnutrition among older people should not be overlooked. Despite rapid pace of socioeconomic development, the problem of underweight still occurs in the country. The significant problem of under-nutrition among the population and malnutrition risk among older individuals and their associated implications on health care deserves serious attention as the country's proportion of the elderly is on the rise.

7. CONCLUSION

The NHMS III showed that the national overall prevalence of underweight among adults at 8.5% was three times lower than the prevalence of 25.2% reported in the NHMS II, in 1996. However, the prevalence of overweight was higher in the present study (28.6%) compared to the latter (16.6%), and comparable to that reported in the Malaysian Adults Nutrition Survey (MANS) 2003 (27.4%). It is important to note that the obesity rate has increased rapidly over the past decade, from 4.4% in 1996 (NHMS II) to 12.7% in 2003 (MANS) and 14.2% at present. In addition, the overall national prevalence of abdominal obesity was found to be high (17.4%). Meanwhile, it was found that the prevalence of underweight among older individuals aged 60 years and above has decreased from 29.4% in 1996 to 11.0% at present, but the prevalence of overweight increased. In addition, a quarter of the elderly population had peripheral muscle wasting or at risk of malnutrition based on the calf circumference measurement. The alarming trend for the rise of overweight and obesity calls for immediate revision of public health policies and for effective health programmes in prevention and intervention strategies.

8. RECOMMENDATIONS

8.1 Sharing Responsibility

Strategies to improve the nutritional status of the Malaysian population are a shared responsibility of the various stakeholders. Both short term and long term strategies are required. The stakeholders should not involve only the government sector, but also others such as the food industry, non-government organizations, the media, professional societies and the community (e.g. schools, work sites). The key players need to share the responsibility and actively participate in the strategies planned by the programme managers.

8.2 Smart Partnership

Many strategies have been identified in the Second National Plan of Action (NPAN II 2006-2015) to combat nutritional problems in the population. In order to move forward these strategies, there is a need for continuous support and commitment by all stakeholders in a smart partnership. For example, the partnership among the food industry, NGOs, professional societies and government agencies to promote healthy lifestyles can be further enhanced.

8.3 Building and Strengthening Capacity of Trained Professionals

Trained professionals in nutrition, dietetics, food science as well as related fields such as psychology, physical activity and communications are needed to conduct studies and interventions in health promotion and reduction of the risks of non-communicable diseases. In this context, capacity building is imperative in order to strengthen these trained professionals to enable them to conduct effective health promotion activities in the targeted community.

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APPENDIX



APPENDIX 1

Table 1: Summary of measurements and equipment used for individuals aged 18 years and above in the NHMS 3

Age group	Measurement	Equipment
Adults \geq 18 years to <60 years	Weight	Tanita Digital weighing scale
	Height	Seca Bodymeter
	Waist circumference	Seca Measurement tape
Elderly \geq 60 years	Weight	Tanita Digital weighing scale
	Height	Seca Bodymeter
	Calf circumference	Seca measuring tape
	Half arm span*	Seca measuring tape

*proxy measurement for height in elderly people who are unable to stand upright or had kyphosis

Table 2: Nutritional status indicators, classification and cut-off points

Indicator	Classification	Cut-off points
BMI (kg/m ²) (WHO 1995)	Underweight	<18.5
	Normal	18.5-24.9
	Overweight	25.0-29.9
	Obesity I	30.0-34.9
	Obesity II	35.0-39.9
	Extremely obese (class III)	\geq 40.0
Waist circumference (WHO 1998)	Abdominal Obesity	> 102 cm (Men)
		> 88 cm (Women)
Calf circumference (\geq 60 years) (Sakinah et al. 2004)	Peripheral Muscle Wasting (Risk of malnutrition)	< 30.1 cm (Men)
		< 27.3 cm (Women)

Table 3: Prevalence of normal body mass index (BMI 18.5-24.9 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Normal	16,012	5,981,356	48.4	47.7	49.0
State					
Johor	1,830	711,713	48.8	46.9	50.6
Kedah	1,113	398,931	45.0	42.6	47.4
Kelantan	924	306,629	48.3	46.1	50.6
Malacca	368	151,818	43.4	39.7	47.3
N. Sembilan	550	200,321	43.7	40.9	46.5
Pahang	842	323,628	47.1	44.4	49.9
Penang	998	357,814	47.8	45.1	50.5
Perak	1,288	540,933	50.8	48.6	52.9
Perlis	126	45,273	40.1	34.3	46.2
Selangor	2,628	1,083,782	46.4	44.8	47.9
Terengganu	609	206,441	45.4	42.7	48.1
Sabah	2,098	642,633	54.8	53.0	56.6
Sarawak	1,484	577,843	51.4	49.4	53.4
W.P. Kuala Lumpur	906	356,593	50.4	47.8	53.0
W.P. Labuan	248	77,005	46.7	42.3	51.1
Residence					
Urban	9,483	3,869,652	48.4	47.5	49.2
Rural	6,529	2,111,704	48.4	47.4	49.4
Gender					
Male	7,920	2,925,691	52.0	51.2	52.9
Female	8,092	3,055,665	45.3	44.5	46.1
Age Group					
18-19	971	357,525	57.7	55.2	60.1
20-24	2,166	809,162	58.9	57.3	60.6
25-29	1,889	711,212	54.3	52.5	56.1
30-34	1,756	656,874	52.5	50.8	54.3
35-39	1,657	616,428	47.3	45.5	49.0
40-44	1,684	633,940	44.7	43.0	46.3
45-49	1,431	534,843	40.9	39.2	42.6
50-54	1,202	453,534	39.7	38.0	41.6
55-59	1,009	379,154	40.9	38.9	42.9
60-64	730	269,778	44.8	42.4	47.1
65-69	654	241,797	47.8	45.1	50.4
70-74	434	158,618	50.0	46.6	53.4
75-79	240	88,662	53.9	49.2	58.5
80+	189	69,830	57.2	51.6	62.5

Table 3: Prevalence of normal body mass index (BMI 18.5-24.9 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	8,206	3,027,616	45.1	44.3	45.9
Chinese	3,648	1,468,068	54.4	53.2	55.7
Indian	1,135	449,912	41.4	39.4	43.5
Other Bumis	1,996	662,465	52.0	50.2	53.9
Others	1,027	373,296	62.5	59.8	65.2
Education					
None	1,713	603,163	48.8	47.0	50.6
Primary	4,455	1,633,050	46.6	45.5	47.6
Secondary	8,040	3,036,481	48.6	47.8	49.5
Tertiary	1,637	647,633	51.1	49.3	53.0
Non Classified	167	61,028	53.6	47.5	59.6
Occupation					
Senior Official & Manager	276	109,329	44.1	40.2	48.2
Professionals	1,025	402,509	47.4	45.3	49.6
Technical & Associate	1,167	448,727	45.3	43.3	47.3
Clerical Workers	842	325,323	48.1	45.7	50.4
Service Workers & Shop	2,680	1,019,393	49.1	47.7	50.4
Skilled Agricultural & Fishery	1,476	498,711	55.6	53.4	57.7
Craft & Related Trade Workers	1,071	410,243	55.0	52.5	57.4
Plant & Machine Operator & Assembler	930	347,479	50.3	48.0	52.7
Elementary Occupations	907	319,251	57.9	55.3	60.6
Housewife	3,077	1,148,998	40.7	39.5	41.9
Unemployed	1,669	606,434	51.0	49.3	52.8
Unclassified	892	344,958	54.9	52.2	57.6
Marital Status					
Not married	4,127	1,548,008	57.8	56.5	59.1
married	10,732	4,005,003	46.0	45.3	46.7
Divorcee	348	131,797	48.8	45.1	52.5
Widower	744	274,295	41.9	39.6	44.3
Not applicable	61	22,252	40.9	32.4	49.9
Income					
Less than RM 400	1,467	513,578	51.8	49.8	53.7
RM 400 - RM 699	2,436	847,151	49.9	48.3	51.5
RM 700 - RM 999	1,782	645,938	47.7	46.0	49.5
RM 1000 - RM 1999	4,008	1,498,089	46.4	45.2	47.5
RM 2000 - RM 2999	2,376	919,437	47.4	46.0	48.9
RM 3000 - RM 3999	1,190	468,991	46.9	44.8	49.1
RM 4000 - RM 4999	597	236,186	46.6	43.5	49.6
RM 5000 & above	1,471	588,602	51.7	49.6	53.7
Unclassified	685	263,383	51.9	49.1	54.6

Table 4: Prevalence of Underweight (BMI < 18.5 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Underweight	2,866	1,053,266	8.5	8.2	8.9
State					
Johor	311	120,193	8.2	7.3	9.2
Kedah	208	74,652	8.4	7.3	9.7
Kelantan	209	69,004	10.9	9.3	12.7
Malacca	67	28,200	8.1	6.2	10.5
N. Sembilan	106	37,535	8.2	6.5	10.3
Pahang	156	60,508	8.8	7.1	10.8
Penang	194	69,298	9.3	7.9	10.8
Perak	226	93,002	8.7	7.6	10.1
Perlis	34	11,894	10.5	7.8	14.1
Selangor	376	154,786	6.6	6.0	7.4
Terengganu	147	49,202	10.8	9.3	12.6
Sabah	407	124,224	10.6	9.4	11.9
Sarawak	249	95,085	8.5	7.5	9.5
W.P. Kuala Lumpur	133	52,347	7.4	6.0	9.0
W.P. Labuan	43	13,337	8.1	5.6	11.6
Residence					
Urban	1,542	625,059	7.8	7.4	8.3
Rural	1,324	428,207	9.8	9.2	10.4
Gender					
Male	1,274	463,882	8.3	7.8	8.8
Female	1,592	589,384	8.7	8.3	9.2
Age Group					
18-19	416	152,650	24.6	22.5	26.8
20-24	673	249,591	18.2	16.9	19.6
25-29	376	140,971	10.8	9.7	11.9
30-34	217	80,630	6.5	5.7	7.3
35-39	169	62,633	4.8	4.1	5.6
40-44	151	56,158	4.0	3.4	4.6
45-49	107	38,781	3.0	2.4	3.6
50-54	114	41,619	3.7	3.0	4.4
55-59	113	41,413	4.5	3.7	5.4
60-64	116	41,136	6.8	5.7	8.2
65-69	135	47,657	9.4	8.0	11.1
70-74	106	38,545	12.2	10.1	14.5
75-79	83	29,365	17.8	14.5	21.8
80+	90	32,118	26.3	21.9	31.2

Table 4: Prevalence of Underweight (BMI < 18.5 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	1,575	570,389	8.5	8.0	9.0
Chinese	570	227,697	8.4	7.7	9.2
Indian	209	82,761	7.6	6.6	8.8
Other Bumis	366	121,061	9.5	8.4	10.7
Others	146	51,359	8.6	7.2	10.3
Education					
None	422	145,365	11.8	10.7	12.9
Primary	619	221,942	6.3	5.8	6.9
Secondary	1,537	573,572	9.2	8.7	9.7
Tertiary	260	101,749	8.0	7.1	9.1
Non Classified	28	10,639	9.3	6.6	13.2
Occupation					
Senior Official & Manager	15	5,966	2.4	1.5	4.0
Professionals	141	55,594	6.6	5.5	7.7
Technical & Associate	160	60,697	6.1	5.3	7.1
Clerical Workers	179	68,011	10.1	8.8	11.5
Service Workers & Shop	401	151,593	7.3	6.6	8.1
Skilled Agricultural & Fishery	234	79,011	8.8	7.8	10.0
Craft & Related Trade Workers	198	75,513	10.1	8.7	11.7
Plant & Machine Operator & Assembler	137	49,921	7.2	6.1	8.5
Elementary Occupations	157	53,886	9.8	8.3	11.5
Housewife	478	175,719	6.2	5.7	6.8
Unemployed	515	181,927	15.3	14.1	16.6
Unclassified	251	95,427	15.2	13.5	17.1
Marital Status					
Not married	1,236	458,731	17.1	16.2	18.2
Married	1,342	491,517	5.6	5.3	6.0
Divorcee	77	27,577	10.2	8.2	12.7
Widower	189	67,272	10.3	9.0	11.8
Not applicable	22	8,169	15.0	9.8	22.4
Income					
Less than RM 400	350	118,130	11.9	10.7	13.3
RM 400 - RM 699	503	175,213	10.3	9.5	11.3
RM 700 - RM 999	311	110,975	8.2	7.3	9.2
RM 1000 - RM 1999	716	264,406	8.2	7.6	8.9
RM 2000 - RM 2999	392	151,747	7.8	7.1	8.7
RM 3000 - RM 3999	182	71,460	7.2	6.1	8.3
RM 4000 - RM 4999	97	38,167	7.5	5.9	9.5
RM 5000 & above	185	73,344	6.4	5.5	7.5
Unclassified	130	49,824	9.8	8.3	11.6

Table 5: Prevalence of Overweight (BMI 25.0-29.9 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Overweight	9,569	3,598,936	29.1	28.6	29.7
State					
Johor	1,090	421,568	28.9	27.3	30.5
Kedah	765	275,269	31.1	29.2	33.0
Kelantan	541	179,473	28.3	26.1	30.6
Malacca	262	108,502	31.1	27.3	35.0
N. Sembilan	371	135,426	29.5	27.3	31.9
Pahang	514	197,663	28.8	26.5	31.2
Penang	619	219,290	29.3	27.5	31.1
Perak	705	294,083	27.6	25.7	29.6
Perlis	97	36,247	32.1	26.5	38.4
Selangor	1,754	724,589	31.0	29.7	32.3
Terengganu	379	130,023	28.6	25.9	31.5
Sabah	950	292,374	24.9	23.4	26.6
Sarawak	823	322,902	28.7	27.0	30.5
W.P. Kuala Lumpur	536	210,964	29.8	27.5	32.2
W.P. Labuan	163	50,563	30.6	25.8	36.0
Residence					
Urban	5,792	2,373,969	29.7	29.0	30.4
Rural	3,777	1,224,967	28.1	27.3	28.9
Gender					
Male	4,410	1,670,226	29.7	28.9	30.5
Female	5,159	1,928,710	28.6	27.9	29.3
Age Group					
18-19	182	68,568	11.1	9.7	12.6
20-24	502	189,296	13.8	12.6	15.0
25-29	801	303,929	23.2	21.8	24.7
30-34	913	342,282	27.4	25.8	29.0
35-39	1,115	417,106	32.0	30.4	33.6
40-44	1,345	502,264	35.4	33.9	37.0
45-49	1,277	481,813	36.8	35.2	38.5
50-54	1,148	433,030	38.0	36.2	39.7
55-59	925	350,521	37.8	35.8	39.8
60-64	575	214,674	35.6	33.3	38.1
65-69	413	152,415	30.1	27.7	32.6
70-74	244	92,799	29.3	26.3	32.4
75-79	90	34,798	21.1	17.6	25.2
80+	39	15,440	12.6	9.4	16.8

Table 5: Prevalence of Overweight (BMI 25.0-29.9 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	5,378	1,998,301	29.8	29.1	30.5
Chinese	1,925	767,787	28.5	27.3	29.6
Indian	898	360,817	33.2	31.4	35.1
Other Bumis	1,027	347,932	27.3	25.6	29.1
Others	341	124,099	20.8	18.8	23.0
Education					
None	951	342,192	27.7	26.1	29.3
Primary	3,000	1,110,423	31.7	30.7	32.7
Secondary	4,605	1,749,417	28.0	27.3	28.8
Tertiary	933	367,351	29.0	27.4	30.7
Non Classified	80	29,553	26.0	21.3	31.3
Occupation					
Senior Official & Manager	233	92,569	37.4	33.5	41.4
Professionals	704	273,332	32.2	30.2	34.3
Technical & Associate	892	340,846	34.4	32.5	36.4
Clerical Workers	486	186,191	27.5	25.5	29.7
Service Workers & Shop	1,622	618,765	29.8	28.5	31.1
Skilled Agricultural & Fishery	719	245,933	27.4	25.6	29.3
Craft & Related Trade Workers	458	171,500	23.0	21.0	25.1
Plant & Machine Operator & Assembler	548	210,509	30.5	28.4	32.7
Elementary Occupations	342	123,103	22.3	20.1	24.7
Housewife	2,480	925,228	32.8	31.7	33.9
Unemployed	750	282,066	23.7	22.3	25.3
Unclassified	335	128,895	20.5	18.5	22.7
Marital Status					
Not married	1,137	431,131	16.1	15.2	17.0
married	7,631	2,867,392	32.9	32.3	33.6
Divorcee	186	69,797	25.8	22.7	29.3
Widower	570	213,390	32.6	30.5	34.8
Not applicable	45	17,226	31.6	24.1	40.3
Income					
Less than RM 400	696	246,389	24.8	23.1	26.6
RM 400 - RM 699	1,265	446,324	26.3	24.9	27.7
RM 700 - RM 999	1,091	400,871	29.6	28.1	31.2
RM 1000 - RM 1999	2,579	969,712	30.0	29.0	31.0
RM 2000 - RM 2999	1,518	584,965	30.2	28.9	31.5
RM 3000 - RM 3999	780	305,689	30.6	28.7	32.5
RM 4000 - RM 4999	415	161,822	31.9	29.3	34.6
RM 5000 & above	870	346,284	30.4	28.7	32.2
Unclassified	355	136,881	27.0	24.5	29.6

Table 6: Prevalence of Obesity (BMI ≥ 30.0 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Obese	4,608	1,732,659	14.0	13.6	14.5
State					
Johor	542	206,067	14.1	12.8	15.5
Kedah	386	137,605	15.5	14.0	17.2
Kelantan	239	79,384	12.5	11.1	14.0
Malacca	157	60,954	17.4	14.4	21.0
N. Sembilan	236	85,200	18.6	16.0	21.4
Pahang	278	104,846	15.3	13.3	17.5
Penang	291	102,177	13.7	11.9	15.6
Perak	333	137,783	12.9	11.7	14.2
Perlis	52	19,455	17.2	12.6	23.2
Selangor	927	375,111	16.0	14.9	17.2
Terengganu	205	68,872	15.2	13.4	17.2
Sabah	377	113,789	9.7	8.7	10.8
Sarawak	331	129,148	11.5	10.2	12.9
W.P. Kuala Lumpur	225	88,164	12.5	10.7	14.4
W.P. Labuan	79	24,104	14.6	11.3	18.8
Residence					
Urban	2,793	1,135,045	14.2	13.6	14.8
Rural	1,865	597,613	13.7	13.0	14.4
Gender					
Male	1,512	562,682	10.0	9.5	10.5
Female	3,146	1,169,977	17.4	16.7	18.0
Age Group					
18-19	113	41,403	6.7	5.5	8.1
20-24	334	124,869	9.1	8.1	10.2
25-29	416	153,780	11.7	10.6	12.9
30-34	464	170,729	13.7	12.5	14.9
35-39	554	208,294	16.0	14.8	17.3
40-44	613	226,468	16.0	14.8	17.2
45-49	674	252,679	19.3	18.0	20.7
50-54	574	212,959	18.7	17.3	20.1
55-59	416	156,470	16.9	15.4	18.4
60-64	207	76,909	12.8	11.2	14.5
65-69	171	64,412	12.7	11.0	14.6
70-74	76	27,120	8.6	6.9	10.6
75-79	32	11,800	7.2	5.1	10.0
80+	14	4,766	3.9	2.2	6.8

Table 6: Prevalence of Obesity (BMI \geq 30.0 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	3,014	1,115,839	16.6	16.0	17.3
Chinese	598	233,898	8.7	8.0	9.4
Indian	486	192,708	17.7	16.3	19.3
Other Bumis	424	141,923	11.2	10.1	12.3
Others	136	48,291	8.1	6.7	9.7
Education					
None	411	144,908	11.7	10.7	12.9
Primary	1,477	541,997	15.5	14.7	16.2
Secondary	2,353	883,355	14.2	13.6	14.8
Tertiary	385	149,745	11.8	10.7	13.1
Non Classified	32	12,654	11.1	7.9	15.5
Occupation					
Senior Official & Manager	102	39,897	16.1	13.3	19.3
Professionals	304	117,109	13.8	12.3	15.4
Technical & Associate	368	139,963	14.1	12.8	15.6
Clerical Workers	255	97,257	14.4	12.7	16.2
Service Workers & Shop	773	287,851	13.9	12.9	14.8
Skilled Agricultural & Fishery	220	74,157	8.3	7.2	9.5
Craft & Related Trade Workers	233	88,836	11.9	10.4	13.7
Plant & Machine Operator & Assembler	226	82,539	12.0	10.5	13.5
Elementary Occupations	152	54,722	9.9	8.5	11.6
Housewife	1,547	573,332	20.3	19.4	21.3
Unemployed	323	117,977	9.9	8.9	11.0
Unclassified	155	59,017	9.4	8.0	11.0
Marital Status					
Not married	643	240,263	9.0	8.3	9.8
Married	3,621	1,345,051	15.4	14.9	16.0
Divorcee	107	41,049	15.2	12.6	18.2
Widower	270	99,507	15.2	13.6	17.0
Not applicable	17	6,789	12.5	7.9	19.2
Income					
Less than RM 400	323	113,919	11.5	10.3	12.8
RM 400 - RM 699	652	228,969	13.5	12.4	14.6
RM 700 - RM 999	536	195,550	14.5	13.3	15.7
RM 1000 - RM 1999	1,348	498,820	15.4	14.6	16.3
RM 2000 - RM 2999	735	282,001	14.6	13.5	15.7
RM 3000 - RM 3999	392	153,054	15.3	13.7	17.1
RM 4000 - RM 4999	184	71,128	14.0	12.1	16.3
RM 5000 & above	334	131,357	11.5	10.2	13.0
Unclassified	154	57,860	11.4	9.6	13.4

Table 7: Prevalence of Obesity I (BMI 30-34.9 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Obese I	3,442	1,295,182	10.5	10.1	10.8
State					
Johor	391	151,428	10.4	9.3	11.5
Kedah	282	101,119	11.4	10.2	12.8
Kelantan	178	59,384	9.4	8.2	10.7
Malacca	107	42,232	12.1	9.9	14.7
N. Sembilan	170	61,306	13.4	11.5	15.5
Pahang	205	77,996	11.4	9.9	13.0
Penang	216	76,127	10.2	8.7	11.8
Perak	263	110,113	10.3	9.3	11.5
Perlis	36	13,552	12.0	9.0	15.8
Selangor	669	274,137	11.7	10.8	12.7
Terengganu	151	51,592	11.4	9.9	13.0
Sabah	290	89,468	7.6	6.8	8.6
Sarawak	250	99,266	8.8	7.8	10.0
W.P. Kuala Lumpur	177	69,665	9.8	8.3	11.6
W.P. Labuan	57	17,797	10.8	8.2	14.1
Residence					
Urban	2,072	851,271	10.6	10.2	11.1
Rural	1,370	443,911	10.2	9.6	10.8
Gender					
Male	1,162	439,981	7.8	7.4	8.3
Female	2,280	855,202	12.7	12.2	13.2
Age Group					
18-19	71	27,198	4.4	3.5	5.5
20-24	220	83,604	6.1	5.3	7.0
25-29	279	106,151	8.1	7.2	9.1
30-34	339	125,564	10.0	9.1	11.1
35-39	419	159,022	12.2	11.1	13.3
40-44	455	170,580	12.0	11.0	13.1
45-49	499	187,487	14.3	13.2	15.6
50-54	438	164,146	14.4	13.2	15.7
55-59	322	121,776	13.1	11.8	14.5
60-64	169	63,723	10.6	9.2	12.2
65-69	133	49,637	9.8	8.3	11.5
70-74	61	22,330	7.0	5.5	8.9
75-79	27	9,971	6.1	4.2	8.7
80+	10	3,993	3.3	1.8	6.0

Table 7: Prevalence of Obesity I (BMI 30-34.9 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	2,191	818,403	12.2	11.7	12.7
Chinese	466	185,152	6.9	6.3	7.5
Indian	348	139,599	12.9	11.7	14.1
Other Bumis	329	112,371	8.8	7.9	9.9
Others	108	39,656	6.6	5.4	8.1
Education					
None	318	114,519	9.3	8.3	10.3
Primary	1,084	401,313	11.4	10.8	12.1
Secondary	1,752	664,936	10.7	10.2	11.2
Tertiary	266	105,588	8.3	7.4	9.4
Unclassified	22	8,826	7.8	5.1	11.6
Occupation					
Senior Officials & Managers	79	31,046	12.5	10.1	15.5
Professionals	230	90,974	10.7	9.4	12.2
Technical & Associate	279	106,059	10.7	9.5	12.0
Clerical Workers	190	72,501	10.7	9.3	12.3
Service Workers & Shop	570	214,465	10.3	9.5	11.2
Skilled Agricultural & Fishery	167	57,481	6.4	5.5	7.5
Craft & Related Trade Workers	166	64,967	8.7	7.4	10.2
Plant & Machine Operator & Assembler	169	63,536	9.2	8.0	10.6
Elementary Occupations	118	43,200	7.8	6.6	9.4
Housewife	1,131	422,047	15.0	14.2	15.8
Unemployed	241	89,402	7.5	6.7	8.5
Unclassified	102	39,503	6.3	5.2	7.7
Marital Status					
Not married	425	162,982	6.1	5.5	6.7
Married	2,725	1,021,489	11.7	11.3	12.2
Divorcee	82	32,062	11.9	9.7	14.5
Widower	201	74,973	11.5	10.0	13.1
Not applicable	9	3,678	6.8	3.5	12.5
Income					
Less than RM 400	251	89,509	9.0	8.0	10.2
RM 400 - RM 699	461	164,939	9.7	8.9	10.6
RM 700 - RM 999	397	146,011	10.8	9.8	11.9
RM 1000 - RM 1999	1,012	378,707	11.7	11.1	12.4
RM 2000 - RM 2999	545	210,498	10.9	10.0	11.8
RM 3000 - RM 3999	281	112,022	11.2	9.9	12.7
RM 4000 - RM 4999	136	52,872	10.4	8.8	12.3
RM 5000 & above	239	94,517	8.3	7.3	9.5
Unclassified	120	46,108	9.1	7.6	10.9

Table 8: Prevalence of Obesity II (BMI 35-39.9 kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Obese II	850	319,562	2.6	2.4	2.8
State					
Johor	98	37,278	2.6	2.1	3.2
Kedah	77	27,930	3.2	2.5	4.0
Kelantan	50	16,686	2.6	2.0	3.5
Malacca	38	14,174	4.1	3.0	5.5
N. Sembilan	42	15,386	3.4	2.4	4.7
Pahang	49	18,702	2.7	2.0	3.7
Penang	54	18,983	2.5	1.9	3.4
Perak	47	19,354	1.8	1.4	2.4
Perlis	12	4,452	3.9	2.2	6.9
Selangor	183	75,656	3.2	2.8	3.8
Terengganu	40	13,477	3.0	2.2	4.0
Sabah	56	17,229	1.5	1.1	1.9
Sarawak	58	23,128	2.1	1.6	2.7
W.P. Kuala Lumpur	33	12,988	1.8	1.2	2.7
W.P. Labuan	13	4,137	2.5	1.4	4.6
Residence					
Urban	509	209,626	2.6	2.4	2.9
Rural	341	109,936	2.5	2.3	2.8
Gender					
Male	230	87,068	1.6	1.4	1.8
Female	620	232,493	3.5	3.2	3.8
Age Group					
18-19	27	9,811	1.6	1.1	2.3
20-24	72	27,082	2.0	1.5	2.5
25-29	89	33,438	2.6	2.1	3.1
30-34	87	31,941	2.6	2.1	3.2
35-39	89	33,127	2.5	2.1	3.1
40-44	114	42,385	3.0	2.5	3.6
45-49	128	48,811	3.7	3.2	4.4
50-54	99	38,044	3.3	2.7	4.1
55-59	68	25,752	2.8	2.2	3.5
60-64	34	12,183	2.0	1.5	2.8
65-69	29	11,714	2.3	1.6	3.3
70-74	10	3,775	1.2	0.6	2.2
75-79	3	1,073	0.7	0.2	2.0
80+	1	425	0.4	0.1	2.4

Table 8: Prevalence of Obesity II (BMI 35-39.9 kg/m²) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	574	214,788	3.2	2.9	3.5
Chinese	104	41,276	1.5	1.3	1.9
Indian	91	36,204	3.3	2.7	4.1
Other Bumis	64	21,606	1.7	1.3	2.2
Others	17	5,687	1.0	0.6	1.5
Education					
None	58	21,667	1.8	1.3	2.3
Primary	282	104,597	3.0	2.7	3.4
Secondary	414	156,058	2.5	2.3	2.8
Tertiary	87	33,838	2.7	2.2	3.3
Unclassified	9	3,401	3.0	1.6	5.7
Occupation					
Senior Official & Manager	18	7,116	2.9	1.8	4.5
Professionals	51	19,476	2.3	1.8	3.0
Technical & Associate	64	24,995	2.5	2.0	3.2
Clerical Workers	45	17,909	2.7	2.0	3.5
Service Workers & Shop	144	53,609	2.6	2.2	3.0
Skilled Agricultural & Fishery	34	11,468	1.3	0.9	1.8
Craft & Related Trade Workers	44	16,399	2.2	1.6	3.0
Plant & Machine Operator & Assembler	41	14,977	2.2	1.6	3.0
Elementary Occupations	27	9,961	1.8	1.2	2.7
Housewife	293	109,912	3.9	3.5	4.4
Unemployed	51	19,119	1.6	1.2	2.1
Unclassified	38	14,620	2.3	1.7	3.2
Marital Status					
Not married	143	53,732	2.0	1.7	2.4
Married	634	238,077	2.7	2.5	3.0
Divorcee	16	5,926	2.2	1.4	3.6
Widower	50	19,049	2.9	2.2	3.8
Not applicable	7	2,779	5.1	2.4	10.4
Income					
Less than RM 400	53	19,100	1.9	1.5	2.6
RM 400 - RM 699	129	44,883	2.6	2.2	3.2
RM 700 - RM 999	96	35,153	2.6	2.1	3.2
RM 1000 - RM 1999	223	83,350	2.6	2.3	3.0
RM 2000 - RM 2999	138	54,320	2.8	2.3	3.4
RM 3000 - RM 3999	80	31,094	3.1	2.5	3.9
RM 4000 - RM 4999	32	12,503	2.5	1.7	3.5
RM 5000 & above	76	30,330	2.7	2.1	3.4
Unclassified	23	8829	1.7	1.2	2.6

Table 9: Prevalence of Obesity III (BMI \geq 40kg/m²) by socio-demographic characteristics

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
National					
Obese III	316	117,915	1.0	0.9	1.1
State					
Johor	53	17,361	1.2	0.9	1.6
Kedah	27	8,556	1.0	0.6	1.5
Kelantan	11	3,314	0.5	0.3	1.0
Malacca	12	4,547	1.3	0.8	2.2
N. Sembilan	24	8,509	1.9	1.2	2.8
Pahang	24	8,148	1.2	0.7	1.9
Penang	21	7,067	0.9	0.6	1.5
Perak	23	8,316	0.8	0.5	1.3
Perlis	4	1,451	1.3	0.4	3.8
Selangor	75	25,319	1.1	0.8	1.4
Terengganu	14	3,803	0.8	0.5	1.5
Sabah	31	7,092	0.6	0.4	0.9
Sarawak	23	6,754	0.6	0.4	1.0
W.P. Kuala Lumpur	15	5,510	0.8	0.5	1.3
W.P. Labuan	9	2,169	1.3	0.6	2.8
Residence					
Urban	212	74,149	0.9	0.8	1.1
Rural	154	43,766	1.0	0.8	1.2
Gender					
Male	120	35,633	0.6	0.5	0.8
Female	246	82,282	1.2	1.1	1.4
Age Group					
18-19	15	4,394	0.7	0.4	1.3
20-24	42	14,183	1.0	0.7	1.4
25-29	48	14,191	1.1	0.8	1.5
30-34	38	13,224	1.1	0.8	1.5
35-39	46	16,144	1.2	0.9	1.7
40-44	44	13,504	1.0	0.7	1.3
45-49	47	16,381	1.3	0.9	1.7
50-54	37	10,768	0.9	0.7	1.4
55-59	26	8,943	1.0	0.6	1.5
60-64	4	1,003	0.2	0.1	0.5
65-69	9	3,060	0.6	0.3	1.2
70-74	5	1,015	0.3	0.1	1.0
75-79	2	756	0.5	0.1	1.8
80+	3	348	0.3	0.0	2.0

Table 9: Prevalence of Obesity III (BMI $\geq 40\text{kg/m}^2$) by socio-demographic characteristics (continue)

Sociodemography	Total Respondent	Estimated Population	Prevalence %	95% CI	
				Lower	Upper
Ethnic Group					
Malay	249	82,647	1.2	1.1	1.4
Chinese	28	7,470	0.3	0.2	0.4
Indian	47	16,904	1.6	1.1	2.1
Other Bumis	31	7,946	0.6	0.4	1.0
Others	11	2,948	0.5	0.3	0.9
Education					
None	35	8,722	0.7	0.5	1.0
Primary	111	36,087	1.0	0.8	1.3
Secondary	187	62,362	1.0	0.9	1.2
Tertiary	32	10,319	0.8	0.6	1.2
Unclassified	1	426	0.4	0.1	2.6
Occupation					
Senior Official & Manager	5	1,735	0.7	0.3	1.8
Professionals	23	6,659	0.8	0.5	1.3
Technical & Associate	25	8,909	0.9	0.6	1.4
Clerical Workers	20	6,847	1.0	0.6	1.7
Service Workers & Shop	59	19,777	1.0	0.7	1.3
Skilled Agricultural & Fishery	19	5,208	0.6	0.4	1.0
Craft & Related Trade Workers	23	7,469	1.0	0.6	1.6
Plant & Machine Operator & Assembler	16	4,026	0.6	0.3	1.1
Elementary Occupations	7	1,561	0.3	0.1	0.8
Housewife	123	41,373	1.5	1.2	1.8
Unemployed	31	9,456	0.8	0.5	1.2
Unclassified	15	4,895	0.8	0.4	1.4
Marital Status					
Not married	75	23,550	0.9	0.7	1.1
Married	262	85,486	1.0	0.9	1.1
Divorcee	9	3,062	1.1	0.5	2.5
Widower	19	5,485	0.8	0.5	1.4
Not applicable	1	332	0.6	0.1	4.2
Income					
Less than RM 400	19	5,310	0.5	0.3	0.9
RM 400 - RM 699	62	19,146	1.1	0.9	1.5
RM 700 - RM 999	43	14,386	1.1	0.8	1.5
RM 1000 - RM 1999	113	36,764	1.1	0.9	1.4
RM 2000 - RM 2999	52	17,184	0.9	0.7	1.2
RM 3000 - RM 3999	31	9,938	1.0	0.6	1.5
RM 4000 - RM 4999	16	5,754	1.1	0.7	1.9
RM 5000 & above	19	6,510	0.6	0.4	0.9
Unclassified	11	2,923	0.6	0.3	1.2

Table 10: Prevalence of abdominal obesity by socio-demographic characteristics

Independent Variables	Waist Circumference									
	Normal					Abdominal obesity				
	N	Estimated Population	%	Confidence Interval 95%		N	Estimated Population	%	Confidence Interval 95%	
				Lower	Upper				Lower	Upper
Total	27,224	10,165,569	82.6	82.1	83.1	5,676	2,143,585	17.4	16.9	17.9
Age group (Years)										
18-19	1,591	587,325	95.5	94.4	96.4	74	27,615	4.5	3.6	5.6
20-24	3,389	1,265,801	92.8	91.8	93.6	259	98,783	7.2	6.4	8.2
25-29	3,066	1,155,414	88.5	87.3	89.6	393	149,709	11.5	10.4	12.7
30-34	2,859	1,067,766	85.7	84.4	86.9	476	178,349	14.3	13.1	15.6
35-39	2,896	1,078,958	83.0	81.7	84.3	582	220,446	17.0	15.7	18.4
40-44	3,033	1,133,913	80.2	78.8	81.4	742	280,861	19.9	18.6	21.2
45-49	2,685	1,004,129	77.0	75.6	78.5	788	299,402	23.0	21.6	24.5
50-54	2,287	861,100	75.3	73.7	76.9	748	281,870	24.7	23.1	26.3
55-59	1,806	679,904	73.6	71.8	75.3	643	243,751	26.4	24.7	28.2
60-64	1,236	456,960	76.7	74.5	78.7	373	139,226	23.4	21.3	25.5
65-69	1,053	387,224	77.0	74.7	79.1	309	115,762	23.0	20.9	25.3
70-74	676	249,817	80.1	77.2	82.7	169	62,207	19.9	17.4	22.8
75-79	365	133,947	82.9	79.1	86.2	73	27,551	17.1	13.8	20.9
80+	282	103,312	85.1	80.8	88.6	47	18,053	14.9	11.4	19.2
Sex										
Male	13,988	5,201,778	92.8	92.4	93.3	1,051	401,879	7.2	6.7	7.6
Female	13,236	4,963,791	74.0	73.3	74.8	4,625	1,741,706	26.0	25.2	26.8
Ethnic Group										
Malay	14,765	5,451,005	81.5	80.8	82.1	3,323	1,241,453	18.6	17.9	19.2
Chinese	5,716	2,295,199	85.9	84.9	86.9	951	376,586	14.1	13.2	15.1
Indian	1,954	778,582	71.8	69.9	73.7	764	305,177	28.2	26.3	30.1
Other Bumis	3,315	1,105,741	87.3	86.0	88.5	473	161,446	12.7	11.6	14.0
Others	1,474	535,043	90.1	88.3	91.7	165	58,924	9.9	8.4	11.7
Strata										
Urban	16,016	6,539,623	82.0	81.4	82.7	3,486	1,433,405	18.0	17.3	18.7
Rural	11,208	3,625,947	83.6	82.8	84.4	2,190	710,181	16.4	15.6	17.2
Socioeconomic Status										
< RM 400	2,342	816,437	82.8	81.2	84.3	473	169,334	17.2	15.7	18.8
RM 400 - < 700	4,043	1,412,151	83.5	82.3	84.7	784	278,730	16.5	15.4	17.7
RM 700 - < 1000	3,038	1,102,055	81.7	80.2	83.0	665	247,266	18.3	17.0	19.8
RM 1000 - < 2000	7,033	2,626,673	81.8	80.9	82.7	1,551	584,638	18.2	17.3	19.1
RM 2000 - < 3000	4,078	1,573,936	81.6	80.4	82.8	913	355,094	18.4	17.2	19.6
RM 3000 - < 4000	2,063	811,960	81.7	79.9	83.4	462	182,119	18.3	16.6	20.1
RM 4000 - < 5000	1,070	419,603	83.0	80.7	85.1	217	85,938	17.0	15.0	19.3
RM ≥ 5000	2,455	979,844	86.1	84.6	87.5	398	158,222	13.9	12.5	15.4

Table 10: Prevalence of abdominal obesity by socio-demographic characteristics (continue)

Independent Variables	Waist Circumference									
	Normal					Abdominal obesity				
	N	Estimated Population	%	Confidence Interval 95%		N	Estimated Population	%	Confidence Interval 95%	
				Lower	Upper				Lower	Upper
Occupation										
Senior official & manager	530	210,021	84.6	81.5	87.3	96	38,214	15.4	12.7	18.5
Professionals	1,870	731,578	86.3	84.7	87.7	296	116,285	13.7	12.3	15.3
Technical & associate	2,234	854,354	86.5	85.1	87.9	343	132,860	13.5	12.1	14.9
Clerical workers	1,474	565,532	84.2	82.4	85.9	272	105,763	15.8	14.1	17.6
Service workers & shop	4,599	1,747,371	84.5	83.4	85.4	849	321,754	15.6	14.6	16.6
Skilled agricultural	2,382	807,954	90.5	89.2	91.6	249	84,971	9.5	8.4	10.8
Craft & related trade	1,715	653,075	87.6	85.8	89.2	239	92,351	12.4	10.8	14.2
Plant & machine operation	1,670	628,647	91.1	89.7	92.4	164	61,287	8.9	7.6	10.3
Elementary occupation	1,400	494,620	90.2	88.5	91.7	147	53,531	9.8	8.3	11.5
Housewife	5,195	1,930,437	68.7	67.6	69.9	2,339	878,937	31.3	30.2	32.4
Unemployed	2,681	974,771	82.7	81.3	84.1	543	203,768	17.3	15.9	18.7
States										
Johor	3,081	1,198,107	83.0	81.4	84.4	645	246,019	17.0	15.6	18.6
Kedah	2,039	731,091	82.2	80.4	83.8	439	158,705	17.8	16.2	19.6
Kelantan	1,631	541,263	85.5	83.9	86.9	277	91,936	14.5	13.1	16.1
Melaka	699	289,278	83.2	79.7	86.1	150	58,639	16.9	13.9	20.3
N.Sembilan	1,010	366,196	81.0	78.1	83.6	236	86,101	19.0	16.5	21.9
Pahang	1,462	562,099	82.3	80.1	84.3	317	121,142	17.7	15.7	19.9
Pulau Pinang	1,668	594,848	79.6	77.3	81.7	429	152,252	20.4	18.3	22.7
Perak	2,130	891,427	83.9	82.3	85.4	410	171,281	16.1	14.6	17.7
Perlis	223	81,423	72.6	66.6	78.0	84	30,673	27.4	22.0	33.4
Selangor	4,439	1,830,654	78.3	77.0	79.6	1,232	507,033	21.7	20.4	23.0
Terengganu	1,133	384,470	84.5	82.2	86.7	205	70,300	15.5	13.3	17.9
Sabah	3,357	1,028,773	88.1	86.8	89.3	450	138,970	11.9	10.8	13.2
Sarawak	2,403	936,799	84.6	83.0	86.1	431	170,594	15.4	13.9	17.0
W.P Kuala Lumpur	1,492	587,236	83.4	81.1	85.5	297	116,896	16.6	14.5	19.0
W.P Labuan	457	141,905	86.0	83.1	88.5	74	23,043	14.0	11.5	16.9
Marital Status										
Not Married	6,568	2,461,841	92.3	91.6	93.0	535	206,023	7.7	7.1	8.5
Married	18,750	6,997,283	80.8	80.2	81.3	4,422	1,666,949	19.2	18.7	19.8
Divorce	572	215,030	79.4	76.1	82.4	146	55,747	20.6	17.7	23.9
Widow / Widower	1,212	446,361	68.3	66.0	70.5	554	207,226	31.7	29.5	34.0
Educational level										
None	2,663	937,018	76.3	74.8	77.8	803	290,761	23.7	22.2	25.2
Primary	7,504	2,749,064	78.8	77.9	79.7	1,979	738,541	21.2	20.3	22.1
Secondary	13,989	5,276,364	84.8	84.2	85.4	2,471	946,842	15.2	14.6	15.9
Tertiary	2,806	1,106,579	87.9	86.7	89.1	383	152,157	12.1	11.0	13.3
Citizenship										
Malaysian	25,274	9,460,794	82.0	81.4	82.5	5,507	2,083,188	18.1	17.5	18.6
Non-Malaysian	1,925	695,265	92.4	91.2	93.5	160	56,828	7.6	6.5	8.8

Table 11: Prevalence of calf circumferences by socio-demographic characteristics

Independent Variables	Calf Circumference									
	Normal					Malnutrition				
	N	Estimated Population	%	Confidence Interval 95%		N	Estimated Population	%	Confidence Interval 95%	
				Lower	Upper				Lower	Upper
Total	3,418	1,265,831	80.0	78.4	81.5	864	316,310	20.0	18.5	21.6
Age group (Years)										
60-64	1,242	460,112	85.9	83.7	87.8	205	75,743	14.1	12.2	16.3
65-69	1,052	388,256	82.5	80.2	84.6	226	82,384	17.5	15.4	19.8
70-74	627	231,453	77.1	73.9	80.1	186	68,657	22.9	19.9	26.1
75-79	302	112,531	71.6	66.8	75.9	123	44,676	28.4	24.1	33.2
80+	195	73,479	62.1	56.3	67.5	124	44,851	37.9	32.5	43.7
Sex										
Male	1,513	560,286	76.3	74.1	78.3	480	174,321	23.7	21.7	25.9
Female	1,905	705,546	83.3	81.5	84.9	384	141,989	16.8	15.1	18.5
Ethnic Group										
Malay	1,751	630,208	78.8	76.5	80.8	479	169,981	21.2	19.2	23.5
Chinese	1,028	409,109	83.3	80.6	85.6	203	82,185	16.7	14.4	19.4
Indian	200	81,063	76.3	70.1	81.6	64	25,191	23.7	18.5	29.9
Other Bumis	385	125,957	79.6	75.4	83.3	98	32,214	20.4	16.7	24.6
Others	54	19,495	74.3	61.5	84.0	20	6,739	25.7	16.0	38.5
Strata										
Urban	1,773	727,237	82.3	80.1	84.2	374	156,761	17.7	15.8	19.9
Rural	1,645	538,595	77.2	74.8	79.4	490	159,549	22.9	20.6	25.2
Socioeconomic Status										
< RM 400	700	249,180	77.4	74.3	80.3	207	72,604	22.6	19.7	25.7
RM 400 - < 700	653	234,117	78.9	75.7	81.7	177	62,767	21.1	18.3	24.3
RM 700 - < 1000	370	136,163	81.4	77.1	85.0	87	31,124	18.6	15.0	22.9
RM 1000 - < 2000	674	253,360	80.1	76.8	83.0	169	62,981	19.9	17.0	23.2
RM 2000 - < 3000	386	146,982	87.0	83.4	89.9	57	21,982	13.0	10.1	16.6
RM 3000 - < 4000	160	61,617	86.5	80.3	90.9	26	9,643	13.5	9.1	19.7
RM 4000 - < 5000	88	33,706	89.8	82.1	94.4	10	3,846	10.2	5.6	17.9
RM ≥ 5000	184	73,240	83.5	77.5	88.2	37	14,441	16.5	11.8	22.5

Table 11: Prevalence of calf circumferences by socio-demographic characteristics (continue)

Independent Variables	Calf Circumference									
	Normal					Malnutrition				
	N	Estimated Population	%	Confidence Interval 95%		N	Estimated Population	%	Confidence Interval 95%	
				Lower	Upper				Lower	Upper
States										
Johor	409	153,510	73.0	67.6	77.7	148	56,851	27.0	22.3	32.4
Kedah	259	92,701	65.7	58.8	72.1	139	48,348	34.3	27.9	41.2
Kelantan	241	80,000	80.5	74.8	85.2	59	19,355	19.5	14.8	25.2
Melaka	50	20,071	46.4	36.2	57.0	59	23,144	53.6	43.0	63.8
N.Sembilan	148	53,401	70.7	63.6	76.9	63	22,117	29.3	23.1	36.4
Pahang	183	69,208	92.2	87.1	95.4	16	5,878	7.8	4.6	12.9
Pulau Pinang	291	104,174	88.4	84.6	91.4	38	13,655	11.6	8.6	15.5
Perak	384	158,974	84.2	79.5	88.0	73	29,880	15.8	12.0	20.6
Perlis	36	13,061	88.0	78.7	93.5	5	1,790	12.1	6.5	21.3
Selangor	452	185,601	84.1	80.1	87.5	87	35,012	15.9	12.5	19.9
Terengganu	161	53,266	88.7	83.5	92.4	21	6,789	11.3	7.6	16.5
Sabah	295	89,582	82.5	77.6	86.5	63	19,031	17.5	13.5	22.4
Sarawak	358	136,448	82.9	78.5	86.6	76	28,113	17.1	13.4	21.5
W.P Kuala Lumpur	110	43,295	89.4	81.5	94.2	13	5,117	10.6	5.8	18.5
W.P Labuan	41	12,538	91.1	79.1	96.5	4	1,231	8.9	3.5	20.9
Marital Status										
Not Married	58	21,657	75.7	64.5	84.3	18	6,936	24.3	15.7	35.5
Married	2,384	882,564	81.1	79.2	82.8	564	206,119	18.9	17.2	20.8
Divorce	148	55,028	70.5	63.6	76.5	62	23,033	29.5	23.5	36.4
Widow / Widower	806	298,871	79.5	76.8	82.0	212	77,007	20.5	18.0	23.2
Educational level										
None	1,341	479,262	77.9	75.7	80.0	380	135,621	22.1	20.0	24.3
Primary	1,520	564,559	79.9	77.8	81.9	384	141,848	20.1	18.1	22.2
Secondary	460	184,369	85.6	81.9	88.6	79	31,107	14.4	11.4	18.1
Tertiary	61	24,655	90.6	81.0	95.6	7	2,568	9.4	4.4	19.1

Table 12: Mean BMI by socio-demographic characteristic

Independent Variables	Mean BMI			
	Mean	Standard Error	Confidence Interval	
			95%	
			Lower	Upper
Total	25.0	0.1	24.9	25.1
Age group (Years)				
18-19	22.3	0.4	21.6	23.1
20-24	22.9	0.2	22.5	23.4
25-29	24.5	0.2	24.1	25.0
30-34	24.9	0.1	24.6	25.1
35-39	25.5	0.1	25.3	25.8
40-44	26.0	0.2	25.7	26.3
45-49	26.4	0.1	26.2	26.7
50-54	26.5	0.2	26.1	26.8
55-59	26.0	0.1	25.8	26.3
60-64	25.1	0.2	24.8	25.4
65-69	24.7	0.2	24.4	25.0
70-74	23.9	0.2	23.5	24.4
75-79	22.6	0.2	22.2	23.1
80+	22.0	0.6	20.9	23.1
Sex				
Male	24.6	0.1	24.4	24.7
Female	25.4	0.1	25.2	25.5
Ethnic Group				
Malay	25.4	0.1	25.2	25.6
Chinese	24.3	0.1	24.1	24.5
Indian	25.8	0.2	25.5	26.1
Other Bumis	24.5	0.2	24.1	24.9
Others	23.7	0.2	23.2	24.1
Religion				
Islam	25.3	0.1	25.1	25.4
Kristian	24.4	0.1	24.2	24.7
Buddha	24.2	0.1	24.0	24.4
Hindu	25.7	0.2	25.3	26.0
Others	24.7	0.2	24.2	25.1
Unclassified	24.2	0.8	22.7	25.8
Strata				
Urban	25.1	0.1	25.0	25.3
Rural	24.8	0.1	24.6	25.0
Socioeconomic Status				
< RM 400	24.3	0.3	23.7	24.9
RM 400 - < 700	24.6	0.1	24.4	24.8
RM 700 - < 1000	25.1	0.2	24.7	25.4
RM 1000 - < 2000	25.3	0.1	25.1	25.4
RM 2000 - < 3000	25.2	0.2	24.9	25.5
RM 3000 - < 4000	25.4	0.2	25.1	25.7
RM 4000 - < 5000	25.2	0.2	24.8	25.7
RM ≥ 5000	24.8	0.2	24.5	25.1
Unclassified	24.8	0.4	23.9	25.6

Table 12: Mean BMI by socio-demographic characteristic (continue)

Independent Variables	Mean BMI			
	Mean	Standard Error	Confidence Interval 95%	
			Lower	Upper
Occupation				
Senior official & manager	26.6	0.8	25.0	28.2
Professionals	25.4	0.2	25.0	25.8
Technical & associate	25.4	0.1	25.2	25.6
Clerical workers	25.0	0.3	24.4	25.7
Service workers & shop	25.2	0.2	24.9	25.5
Skilled agricultural	24.0	0.1	23.7	24.3
Craft & related trade	24.2	0.2	23.8	24.5
Plant & machine operation	24.9	0.2	24.6	25.3
Elementary occupation	24.0	0.2	23.5	24.5
Housewife	26.1	0.1	25.9	26.3
Unemployed	23.7	0.2	23.3	24.1
Unclassified	23.4	0.2	23.1	23.7
States				
Johor	25.0	0.1	24.7	25.3
Kedah	25.3	0.2	24.9	25.7
Kelantan	24.6	0.3	24.0	25.2
Melaka	25.5	0.3	24.9	26.0
N.Sembilan	25.5	0.2	25.1	25.9
Pahang	25.2	0.3	24.6	25.8
Pulau Pinang	24.7	0.2	24.4	25.0
Perak	24.8	0.2	24.4	25.2
Perlis	25.3	0.5	24.4	26.3
Selangor	25.6	0.2	25.3	25.9
Terengganu	24.9	0.2	24.5	25.3
Sabah	24.2	0.2	23.7	24.7
Sarawak	24.6	0.2	24.3	24.9
W.P Kuala Lumpur	24.8	0.2	24.4	25.1
W.P Labuan	25.3	0.5	24.4	26.2
Marital Status				
Not Married	23.2	0.2	22.9	23.5
Married	25.6	0.1	25.4	25.7
Divorce	24.8	0.3	24.2	25.3
Widow / Widower	25.2	0.2	24.8	25.5
Unclassified	24.2	0.5	23.2	25.2
Educational level				
None	24.4	0.1	24.2	24.7
Primary	25.4	0.1	25.2	25.6
Secondary	24.9	0.1	24.8	25.1
Tertiary	25.0	0.2	24.5	25.4
Unclassified	24.0	0.3	23.4	24.6
Citizenship				
Malaysian	25.1	0.1	25.0	25.2
Non-Malaysian	23.4	0.2	23.0	23.7
Unclassified	25.9	1.1	23.9	28.0

APPENDIX 2

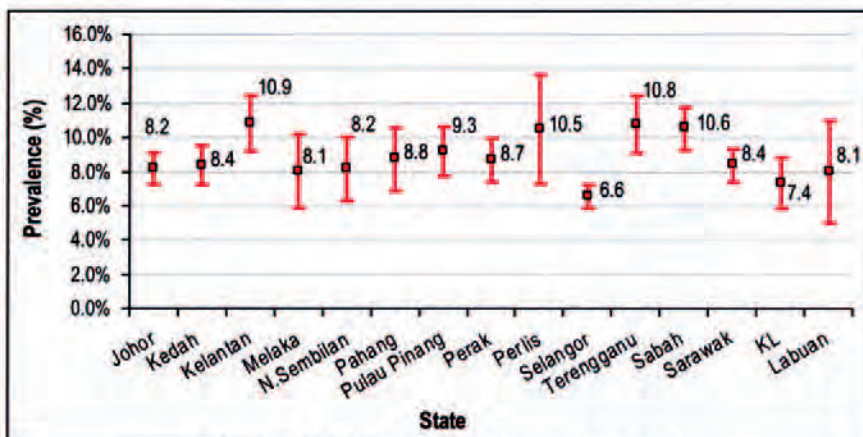


Figure 1: Prevalence of underweight by state

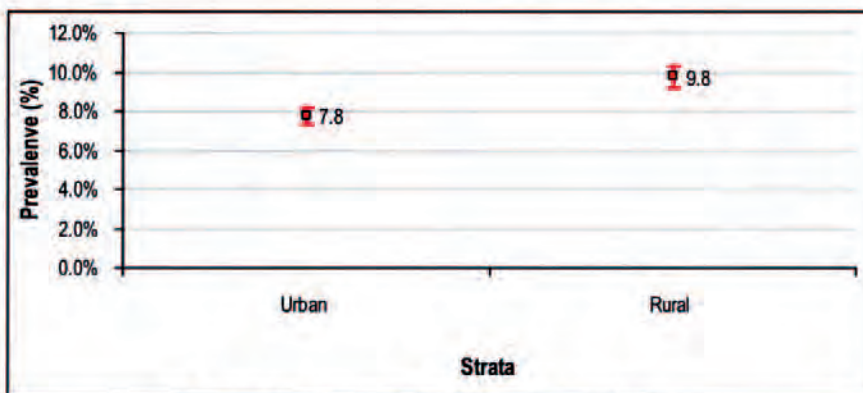


Figure 2: Prevalence of underweight by strata

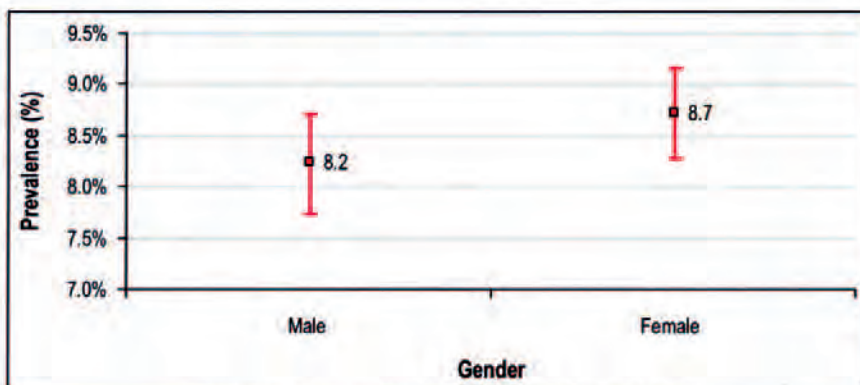


Figure 3: Prevalence of underweight by gender

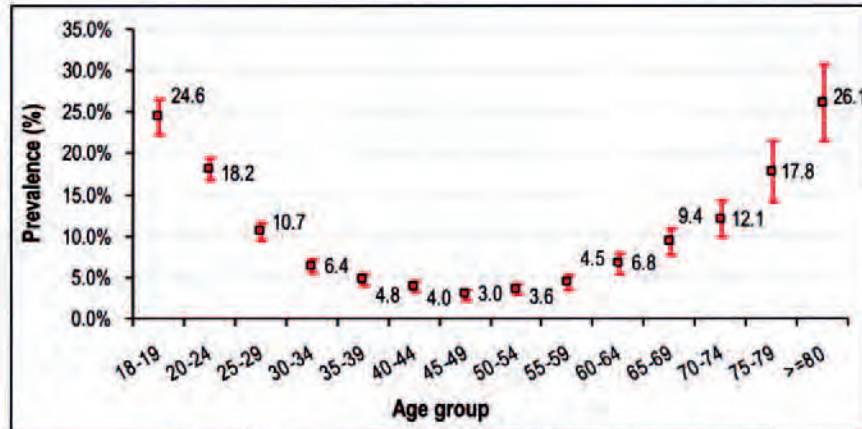


Figure 4: Prevalence of underweight by age group

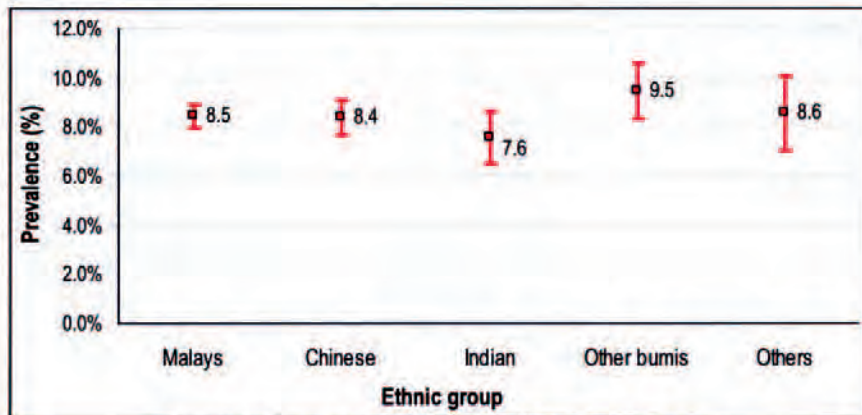


Figure 5: Prevalence of underweight by ethnic group

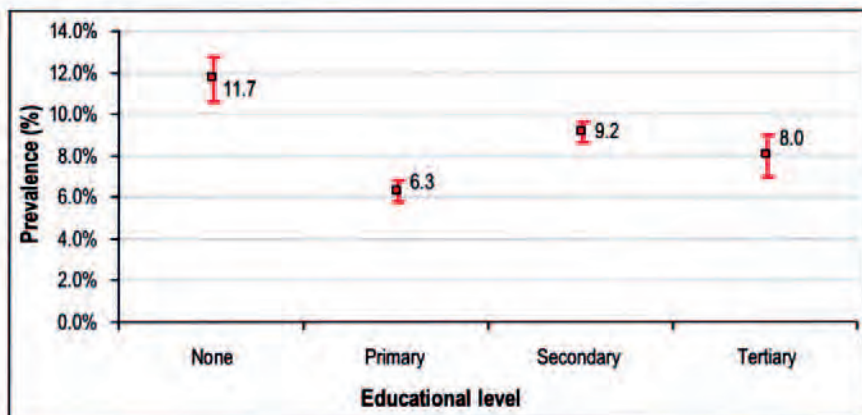


Figure 6: Prevalence of underweight by educational level

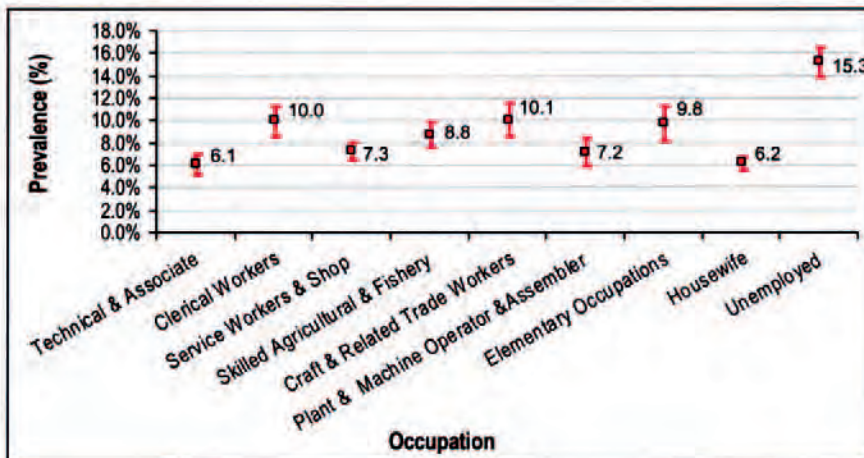


Figure 7: Prevalence of underweight by occupation

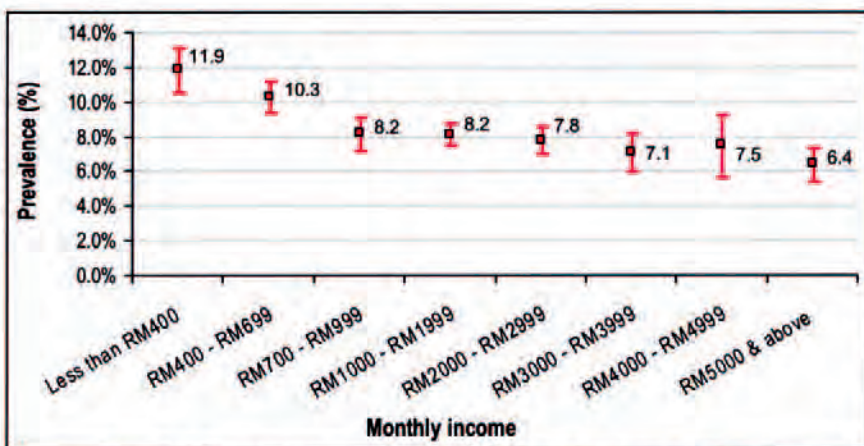


Figure 8: Prevalence of underweight by household monthly income

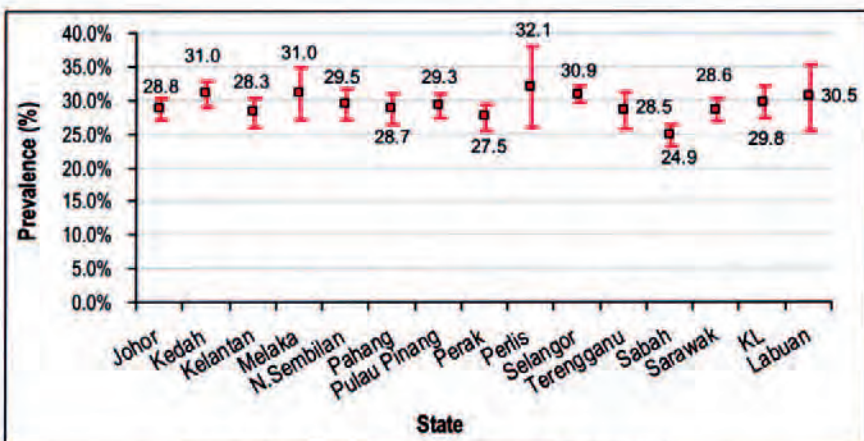


Figure 9: Prevalence of overweight by states

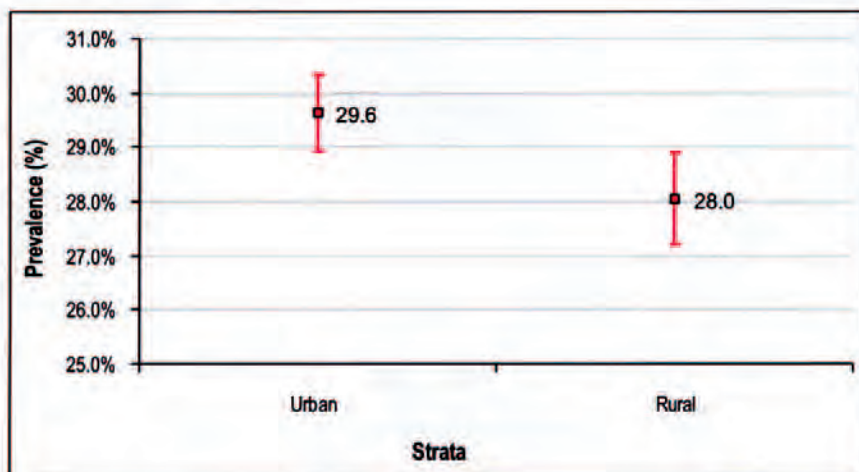


Figure 10: Prevalence of overweight by strata

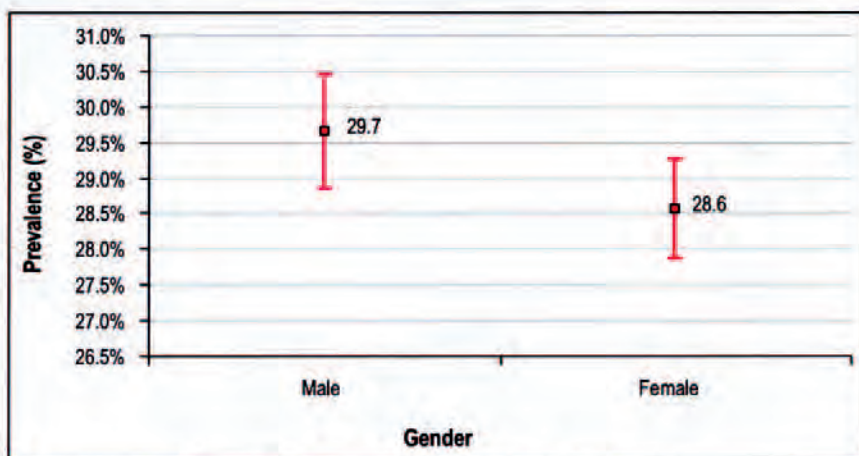


Figure 11: Prevalence of overweight by gender

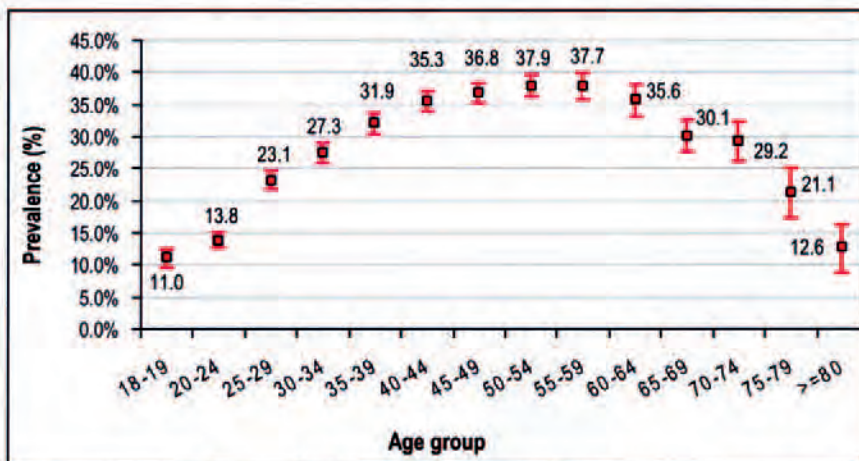


Figure 12: Prevalence of overweight by age

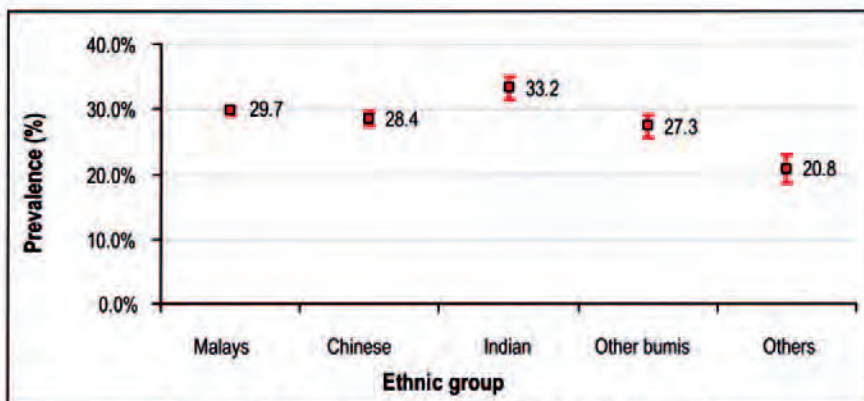


Figure 13: Prevalence of overweight by ethnic group

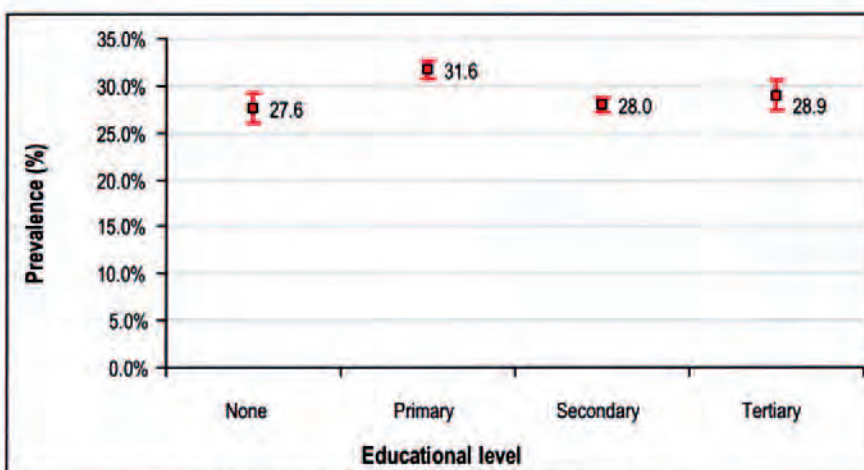


Figure 14: Prevalence of overweight by educational level

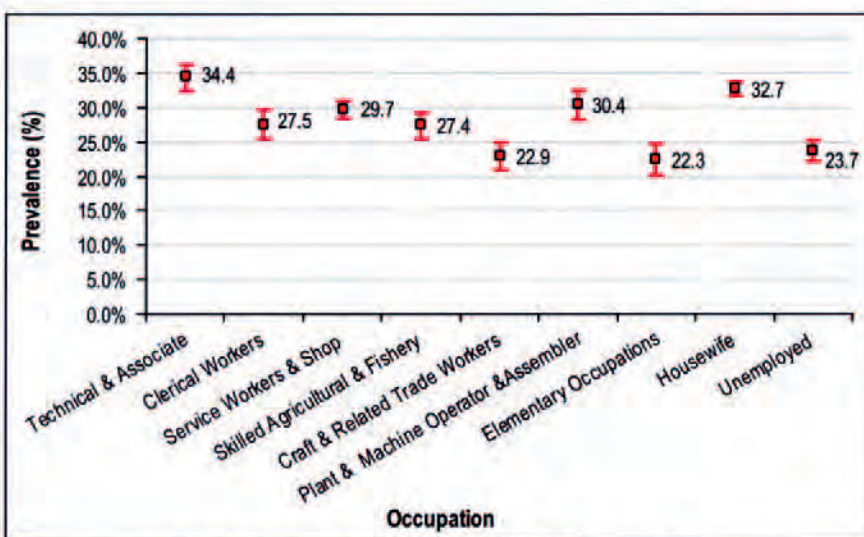


Figure 15: Prevalence of overweight by occupation



Figure 16: Prevalence of overweight by household monthly income

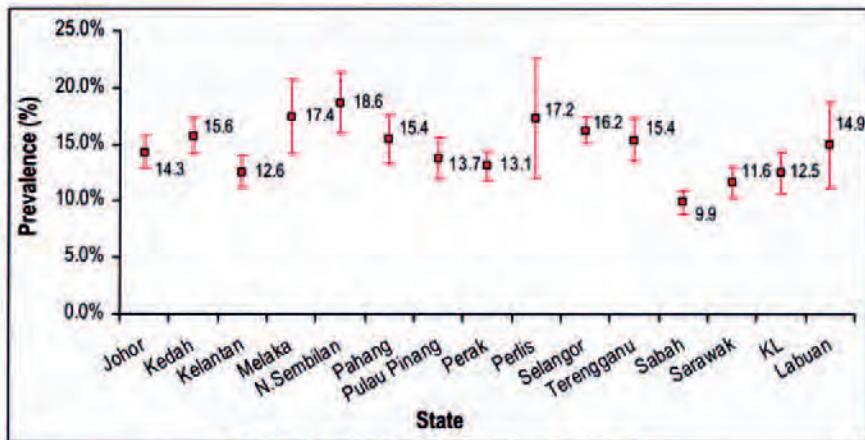


Figure 17: Prevalence of obese by state

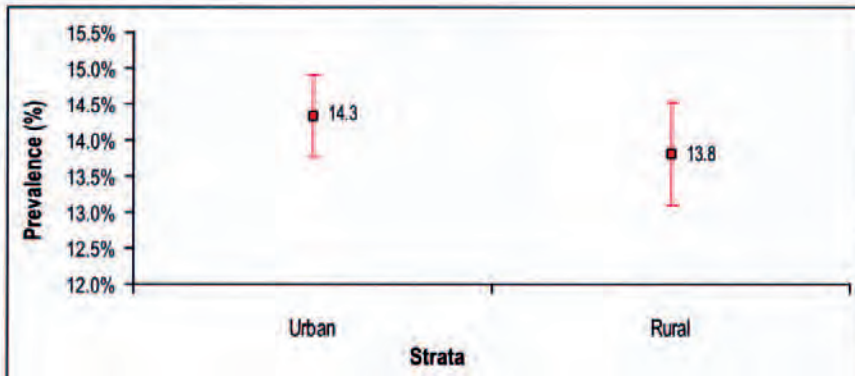


Figure 18: Prevalence of obese by strata

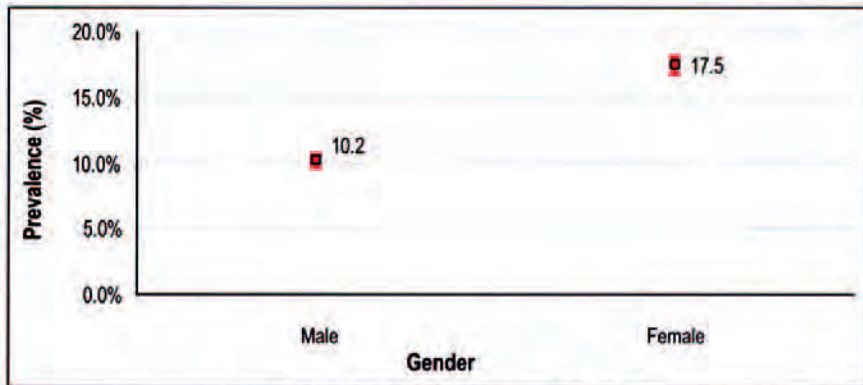


Figure 19: Prevalence of obese by gender

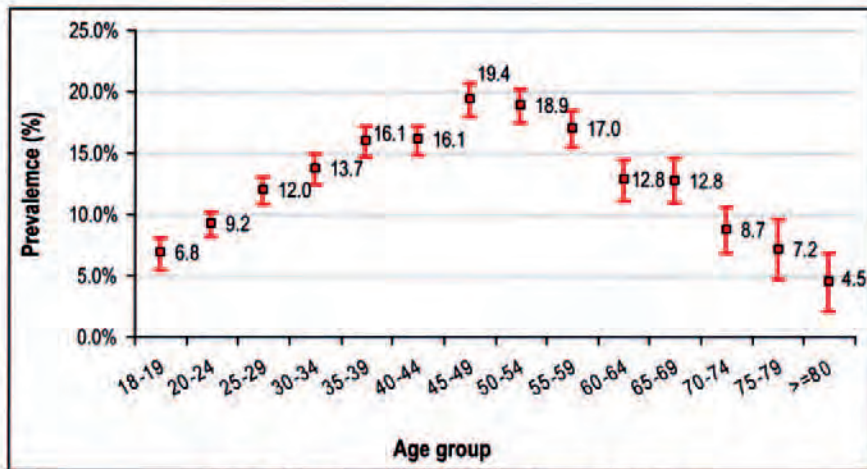


Figure 20: Prevalence of obese by age group

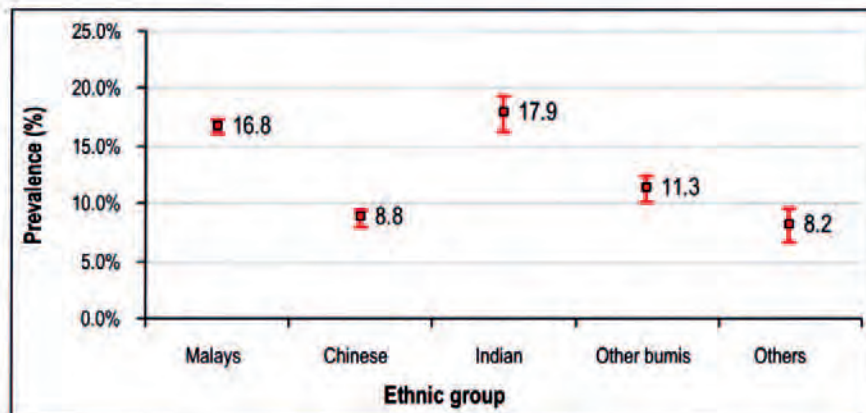


Figure 21: Prevalence of obese by ethnic group

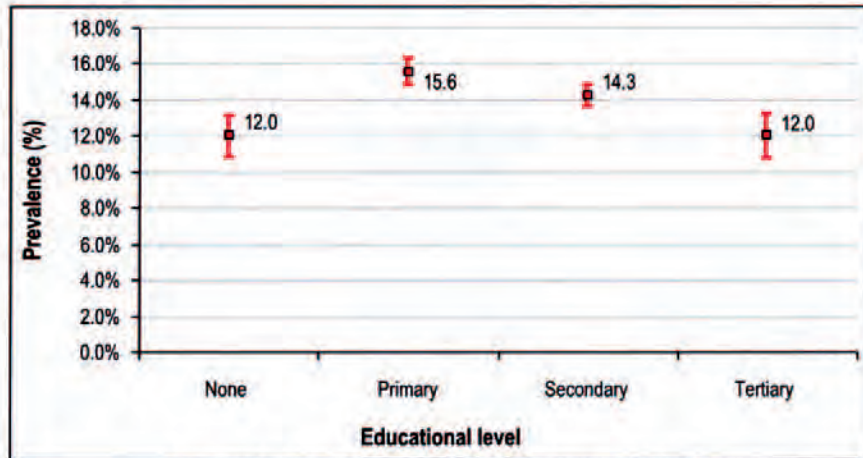


Figure 22: Prevalence of obese by educational level

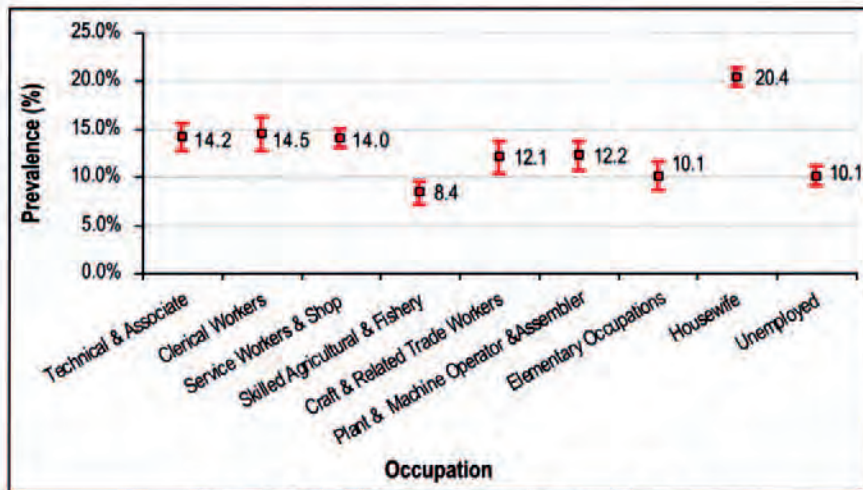


Figure 23: Prevalence of obese by occupation

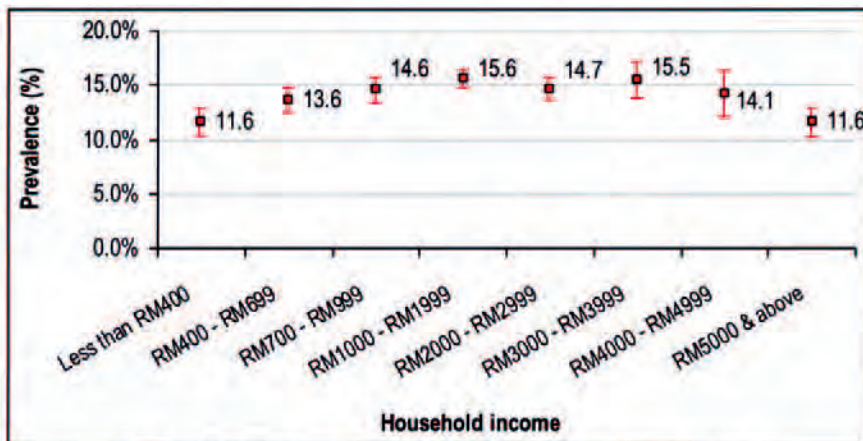


Figure 24: Prevalence of obese by household monthly income

APPENDIX 3

The Reliability and Validity of Anthropometric Measurements used In NHMS III (2006) for Adults

Measurement of the inter and intra-examiner reliability of weight (wt), height (ht) and waist circumference (wc) as well as the validity of test instruments for measuring weight and height compared to their reference instruments was done prior to the actual field study. In December 2005, a convenience sample of 130 adults working in a selected office setting who fit the inclusion and exclusion criteria participated in the study. Two public health nurses, trained to follow a standard protocol, obtained the measurements. Wt was measured using Tanita digital weighing scale, 318, Japan (0.1 kg) and Seca Beam Scale, Germany (0.01 kg) weighing machines. Ht was measured using Seca Bodymeter 206 Germany (0.1cm) and Stadiometer, Germany (0.1cm). Wc was measured using Seca circumference tape, 206, Germany (0.1 cm). There was no reference instrument for wc. The mean age of 130 respondents was 36 (\pm 10.9) years with a median of 36 and a range of 18 to 64 years old. More than two third were female. Malays formed the majority at 83 per cent and the majority had either secondary or tertiary education.

There was a high degree of reliability (both inter and intra examiner) as evidence by low to nil absolute mean difference and high values of intra-class correlation ($r=1$ or very close to 1). For inter-examiner, the Bland and Altman plot on average that the wt measurements taken by the first examiner is consistent (mean difference =0) with the second examiner. The upper and lower limit of the differences are \pm 1.3 kg. Inter examiner ht measurements on average was also consistent (mean difference = 0) with upper and lower limit at \pm 0.9 cm. Inter examiner wc measurements on average examiner 1 was reporting 0.2 cm above that of examiner 1 with the upper and lower limit at + 2.3 and -1.9 cm. By comparison the inter-examiner reliability in descending order would be wt, ht and lastly wc.

For intra-examiner, the Bland and Altman plot on average that the wt measurements at Time1 are consistent (mean difference=0) with Time2. The limits of the difference is \pm 0.9 kg. On average the ht measurements at Time1 are consistent (mean difference=0) with Time2 with limits of the difference \pm 0.9 cm. Wc measurements at Time1 and Time2 on average that Time1 is 0.1 cm higher than Time2 with upper limit and lower limit at +1.3 and -1.1 cm. By comparison the intra-examiner reliability in descending order would be wt and ht followed by wc.

There was a high degree of validity as evidence by low to nil absolute mean difference and high values of intra-class correlation (r close to 1). The Bland and Altman plot for wt measurements showed that on average, the test instrument was consistent with the reference instrument (mean difference =0) with limits of \pm 2 kg. Ht measurement on average using test instrument reported that it was recording 0.4 cm higher than the reference instrument with upper limit and lower limit at 2.5 and 1.6 cm respectively. By comparison, wt had higher degree of reliability than ht in relation to their respective reference standards. The coefficient of variation of weight and length for both inter-examiner and intra-examiner measurements are all within acceptable limit (below 5%).

The findings of this study supports that weight, height and waist circumference measured in adults 30 years and above using Tanita digital weighing scale, 318, Japan (0.1 kg), Seca Bodymeter 206 Germany (0.1cm) and Seca circumference tape, 206, Germany (0.1 cm) are reliable and valid to be used in a community survey. Limiting the number of examiners especially for wc measurements would yield higher degree of reliability and validity.

APPENDIX 4**The Reliability of Anthropometric Measurements used in NHMS III (2006)
for Elderly Persons**

Measurement of the inter and intra-examiner reliability of calf circumference (CC) and half arm span (HAS) was done prior to the actual field study. A convenience sample of 130 elderly persons aged 60 years and above seen consecutively in the Hospital Kuala Lumpur outpatient clinic during the period of December 2005 to January 2006, who fulfilled the inclusion and exclusion criteria, were recruited to the study. Two students in their final year of the Dietetics Degree programme trained to follow a standard protocol obtained the measurements. Both HAS and CC was measured using the Seca Circumference Tape @ 206, Germany (0.05 cm). The mean age of respondents was 66 (± 5.41) years. Two third were male. Almost half (48%) were of Chinese ethnic group followed by Malays (31%) and Indians 20%.

There was a high degree of reliability (both inter and intra examiner) as evidence by low to nil absolute mean difference and high values of intra-class correlation (r close to 1). For inter-examiner, the Bland and Altman plot on average that the CC measurement taken by the first examiner is -0.3 cm lower than the second examiner. The upper and lower limit of the differences are +0.4 to -0.9 cm. Inter examiner HAS measurements on average in first examiner is -0.2 lower than the second examiner. The upper and lower limits are +1.7 to -2.1 cm. By comparison the inter-examiner CC is more reliable than HAS measurements. For intra-examiner, the Bland and Altman plot on average that the CC measurements at Time1 is consistent with Time2 (mean difference =0) with limits of the difference is ± 0.5 cm. HAS measurements at Time1 is on average -0.1 cm less than at Time2 with upper limit and lower limit at +1.7 and -1.8 cm. By comparison the intra-examiner CC measurements for examiner 1 are more reliable compared to that of his HAS measurements.

The coefficient of variation of weight and length for both inter-examiner and intra-examiner measurements are all within acceptable limit (below 5%).

The findings of this study suggest that CC and HAS measured in elderly 60 years and above using Seca Circumference Tape @ 206, Germany (0.05 cm) are reliable to be used in a community survey. Based on this study, CC was had a higher degree of reliability than HAS. However CC was also found to have systematic bias, thus it is suggested that a correction factor of + 1 cm be made for CC readings. Further assessment of CC with a trained anthropometrist acting as "gold standard" would be useful to validate this correction factor.

APPENDIX 5

Report on Data Quality Control for NHMSIII Nutritional Study

1. Introduction

The purpose of this paper is to report the data management process for nutritional data (Module U). The data were entered into a customised system developed for NHMS III. The system was designed using MySQL as the database. The interface was developed using Microsoft Visual Basic. The original data were stored in SQL format and extracted to individual module. The SQL format file was then converted to Microsoft Excel format. Module U that contained nutritional data was then merged with Module A1 that contained information on socio-demographics. Merged dataset was then checked against eligibility criteria. Eligible subjects were then divided into adult and paediatric dataset based on reported age available in Module A1.

2. Findings

2.1 Case Number

Figure 1 summarises the process of data cleaning at the initial phase of the analysis. In-total there were 3,430 missing value, with 3,268 data without socio-economic information, 110 data without information on eligibility and 54 data with no age information. These missing values together with not eligible subjects were dropped from the dataset. The final pre-cleaned data for adult was 33,465.

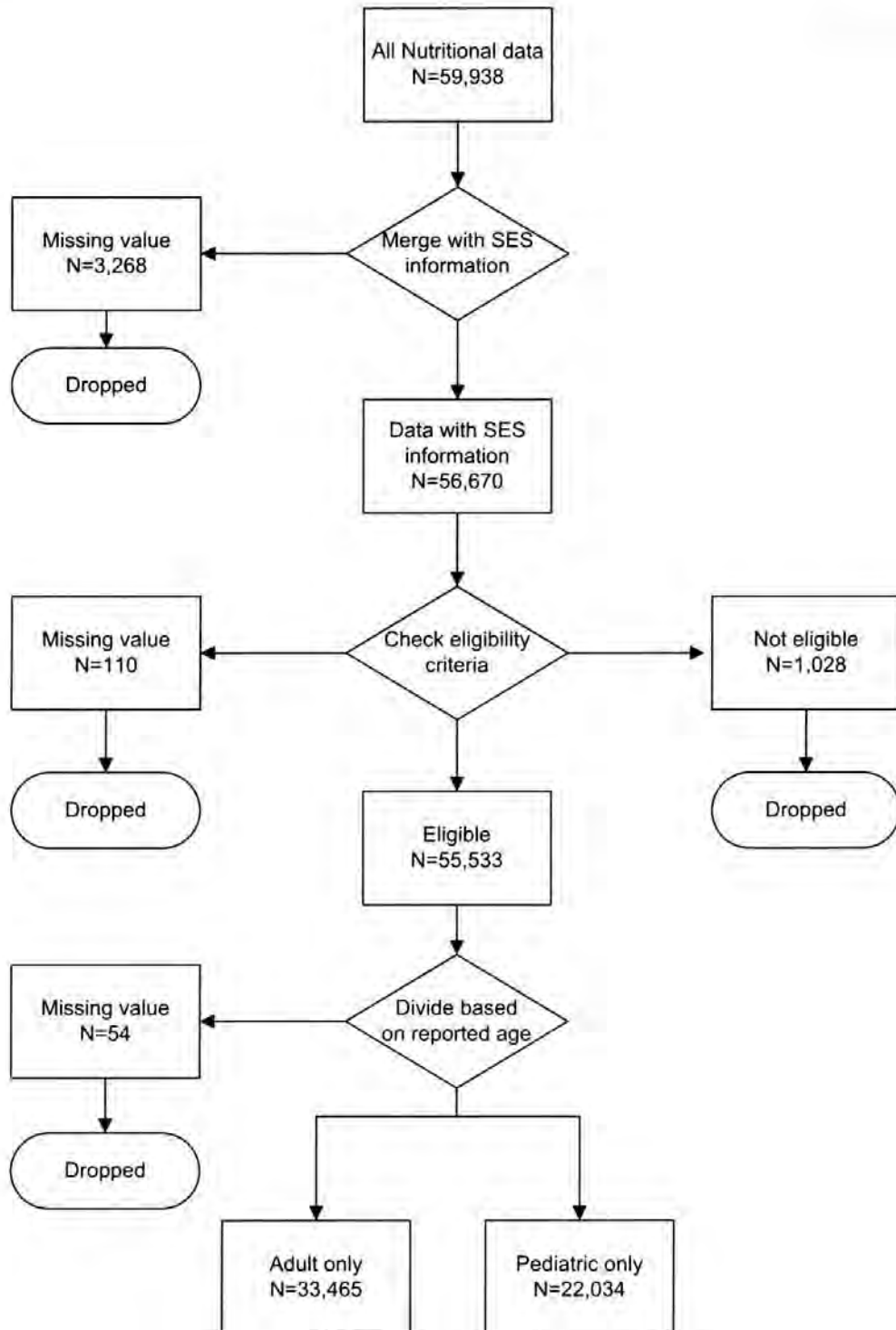


Figure 1: Summary of Eligible Data for Analysis

There were 1028 respondents who had health conditions that may affect nutritional status and therefore were also excluded from the study. The conditions are illustrated in Table 1.

Table 1: Health conditions that affect nutritional status

		N	%
1	Tuberculosis	606	58.9
2	Chronic Renal Diseases	109	10.6
3	Asthma	41	4.0
4	Thyroid Diseases	43	4.2
5	Congenital Heart Diseases	187	18.2
6	Blood Diseases	41	4.0
7	Cancer	1	0.1

2.2 Adult Nutritional Data

The important variables that had been cleaned were weight, height, half-arm span, waist circumference and calf. Weight was measured in kilogram and others in centimetre. All these measurements were taken twice. Half-arm span were measured when enumerator were not able to measure subjects' height due to physical abnormality. Calf circumference was measured for elderly i.e. subjects aged 60 years and above.

Initial quality of data entry for nutritional data for variables mentioned above is shown in Table 2.

Table 2: Summary of Pre-cleaned Data Entered

	N	Minimum	Maximum	Mean	SD
Weight (1st)	33156	0	4660	62.8	36.9
Weight (2nd)	33131	7.5	469	62.5	14.4
Height (1st)	32923	14.2	199.9	158.9	9.9
Height (2nd)	32856	14.2	1530	158.9	14.3
Half-arm span (1st)	282	0	170.5	78.7	13.3
Half-arm span (2nd)	278	0	95.1	77.7	9.7
Waist circumference (1st)	32983	5.2	911	81.8	13.9
Waist circumference (2nd)	32917	5.2	911	81.8	14.0
Calf circumference (1st)	4400	3.5	99.5	31.5	5.8
Calf circumference (2nd)	4386	3.5	98	31.5	5.7

From the table, it is obvious that there were some data entry errors. The summary of errors is presented in Table 3. All errors were verified with the original questionnaire forms and rectified accordingly. There were some measurements which were not measured or entered twice. These missing values were imputed with the other available measurements.

Table 3: Summary of Data Entry Errors for NHMS III Adult Nutritional Data

Problems identified	Measurements			
	Weight N (%)	Height N (%)	Waist Circumference N (%)	Calf Circumference N (%)
Obvious decimal error	3 (<0.001) ⁴	3 (<0.001) ⁵	1 (<0.001) ⁶	-
Obvious typing error	-	3 (<0.001) ⁷	6 (0.018) ⁸	-

⁴ ID involved are 10413049200340100, 080309115101010100 and 060819080400240100.

⁵ ID involved are 060826070201220100, 130104011100650000 and 120611067500580000.

⁶ ID involved is 020629008100420104.

⁷ ID involved are 120815112500110000, 100522010100490000 and 100852006100750000.

⁸ ID involved are 130209076500600101, 100146097100780301, 110417025101070103, 060101002201070102, 010516014400650101 and 030712093400150102.

Not all measurements were available (refer Table 4). Single missing value was 0.1% for weight and 0.2% for height. Complete missing values were less than 2%. Single missing values were then imputed from the other measurement.

Table 4: Summary of Missing Values

	Missing Single Measurement		Missing Two Measurements	
	N	%	N	%
Weight	25	0.1	308	0.9
Height	67	0.2	542	1.6

The summary of the cleaned dataset is presented in Table 5.

Table 5: Summary of Cleaned Data Entered

	N	Minimum	Maximum	Mean	SD
Weight (1st)	33157	7.5	174.9	62.51	14.21
Weight (2nd)	33157	7.5	174.9	62.52	14.21
Height (1st)	32922	43.5	199.9	158.86	9.80
Height (2nd)	32922	43.5	199.9	158.86	9.82
Half-arm span (1st)	282	26	170.5	78.92	12.43
Half-arm span (2nd)	282	26	170.5	78.94	12.44
Waist circumference (1st)	32985	5.2	199.6	81.75	13.16
Waist circumference (2nd)	32985	5.2	199.6	81.76	13.16
Calf circumference (1st)	4401	3.5	99.5	31.51	5.85
Calf circumference (2nd)	4401	3.5	99.5	31.50	5.82

As depicted in Table 5, there are still many outliers. Records for subjects with extreme data were checked. All errors were corrected. The remaining outliers for variables weight and height were cleaned using calculated BMI. Valid BMI was taken within ± 5 SD. Minimum value for waist and calf circumference was set at -3 SD. For calf circumference, only respondents aged 60 years and above were measured. The final cleaned data used for analysis is presented in Table 6.

Table 6: Summary of the Final Cleaned Data*

	N	Minimum	Maximum	Mean	SD
BMI	33055	10.53	72.04	24.72	5.17
Waist Circumference	32900	42.30	199.60	81.88	12.93
Calf Circumference	4280	21.00	43.05	31.21	4.28

* After exclusion of outliers (WC: n = 85, CC: n = 119)