COMPARISON OF THE CLINICAL AND BIOCHEMICAL PROFILE OF METABOLIC SYNDROME BETWEEN OBESE CHILDREN BELOW AND ABOVE 10 YEARS ATTENDING PAEDIATRIC CLINIC HUSM FROM 2006 TO 2015

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ABBREVIATIONS

HUSM	: Hospital Universiti Sains Malaysia
BMI	: Body Mass Index
SBP	: Systolic Blood Pressure
DBP	: Diastolic Blood Pressure
WC	: Waist Circumference
BW	: Birth Weight
AGA	: Appropriate for Gestational Age
SGA	: Small for Gestational Age
LGA	: Large for Gestational Age
NHANES	: National Health and Nutrition Examination Survey
NCEP ATP III	: National Cholesterol Education Program Adult Treatment Panel III
IDF	: International Diabetes Federation
TG	: Serum Triglyceride
HDL	: High Density Lipoprotein Cholesterol
LDL	: Low Density Lipoprotein Cholesterol
FBS/G	: Fasting Blood Sugar/Glucose
CDC	: Centers for Disease Control and Prevention

ABSTRAK

BAHASA MALAYSIA

TAJUK

Perbandingan profil klinikal dan biokimia sindrom metabolik antara kanak-kanak obes di bawah 10 tahun dengan 10 tahun ke atas yang mengikuti rawatan susulan di Klinik Kanak-Kanak HUSM dari 2006 ke 2015

PENGENALAN

Masalah obesiti di kalangan kanak-kanak semakin berleluasa. Bilangan kanak-kanak obes yang semakin meningkat menyebabkan pertambahan kes sindrom metabolik, sekumpulan gangguan biokimia yang jika tidak dikawal akan meningkatkan risiko berlakunya penyakit jantung dan diabetis di peringkat dewasa kelak. Kajian sebelumnya melaporkan kadar sindrom metabolik yang berbeza disebabkan tiada definasi ‘paediatric metabolic syndrome’ yang diterima secara umum.

OBJEKTIF

Untuk menentukan sekiranya terdapat perbezaan ketara sifat klinikal dan biokimia untuk sindrom metabolik antara kanak-kanak obes di bawah 10 tahun dengan kanak-kanak obes 10 tahun ke atas yang telah manjalani rawatan susulan di Klinik Pediatrik HUSM dari tahun 2006 ke 2015.

KAEDAH

Rekod perubatan 84 kanak-kanak obes di bawah 18 tahun yang telah manjalani rawatan susulan di Klinik Pediatrik HUSM dari tahun 2006 ke 2015 dikenalpasti. Maklumat demografik (umur, jantina, kumpulan etnik), klinikal (berat badan, BMI, lilitan pinggang, tekanan darah) dan keputusan makmal (serum triglyceride, total cholesterol, HDL-cholesterol, LDL- cholesterol, fasting blood sugar) mereka direkod, dianalisa dan dibandingkan.

KEPUTUSAN

Bilangan kanak-kanak dibawah 10 tahun yang obes (41 pesakit) hampir sepadan dengan bilangan kanak-kanak obes yang berumur 10 tahun ke atas (43 pesakit). Kebanyakan pesakit di dalam kedua-dua kumpulan umur merupakan lelaki, iaitu 68.2% daripada kanak-kanak obes di bawah 10 tahun berbanding dengan 62.8% daripada kanak-kanak obes 10 tahun ke atas. Umur purata pesakit adalah 9.69 tahun. Bilangan pesakit yang menghidapi sindrom metabolik mengikut kriteria diagnosa IDF adalah 11 pesakit di bawah 10 tahun dan 12 pesakit dengan umur melebihi 10 tahun. Seperti yang dijangka, BMI, lilitan pinggang, tekanan darah sistolik, dan paras triglyceride adalah lebih tinggi dalam kanak-kanak >10 tahun. Tiada perbezaan ketara dalam berat lahir, tekanan darah diastolik, paras kolesterol, HDL, LDL atau fasting plasma glucose antara kedua-dua kumpulan yang dikaji.

KESIMPULAN

Keputusan kajian ini menunjukkan bahawa 31% kanak-kanak obes yang menjalani rawatan susulan di Klinik Pediatrik HUSM turut menghidapi sindrom metabolik. Angka ini adalah sebanding dengan keputusan kajian yang dijalankan di negara maju. Pengesanan komponen sindrom metabolik di kalangan kanak-kanak berumur bawah 10 tahun merupakan perkembangan yang membimbangkan. Justeru itu, langkah-langkah untuk mencegah masalah obesiti di kalangan kanak-kanak perlu dipertingkatkan.

ABSTRACT

ENGLISH

TITLE

Comparison of the clinical and biochemical profile of metabolic syndrome between obese children below and above 10 years attending paediatric clinic HUSM from 2006 to 2015

INTRODUCTION

The burgeoning childhood obesity epidemic predisposes increasing numbers of children to the biochemical derangements that constitute metabolic syndrome, a cluster of metabolic risk factors that if unchecked can progress towards the development of cardiovascular disease and diabetes with their attendant morbidity and mortality in adulthood. Previous studies in children had reported varying rates of prevalence due to a lack of a universally accepted definition for paediatric metabolic syndrome.

OBJECTIVE

To determine if there is a significantly different clinical and biochemical profile of metabolic syndrome between obese children below and above 10 years attending Paediatric Clinic HUSM from 2006-2015

METHODS

The medical records of 84 obese children under 18 years of age who were followed up at Paediatric clinic HUSM from 2006 to 2015 were identified and had their demographic (age, gender, ethnicity), anthropometric, (weight and height), clinical (BMI, systolic and diastolic blood pressure) and biochemical (serum triglyceride, total cholesterol, HDL-cholesterol, LDL- cholesterol, fasting blood sugar) parameters recorded, analysed and compared.

RESULTS

The majority of subjects in both age groups were boys, 68.2% of those less than 10 years and 62.8% in those above 10 years. Mean age of subjects was 9.69 years. An almost equal

number of children had been brought to medical attention for obesity (41 vs 43) and fulfil the IDF criteria for metabolic syndrome (11 vs 12) in both groups. As expected, the mean body mass index, waist circumference, systolic blood pressure, and serum triglyceride levels are significantly higher in children >10 years of age. There were no significant differences in birth weight, diastolic blood pressure, total cholesterol, HDL cholesterol, LDL cholesterol or fasting plasma glucose levels between the 2 groups.

CONCLUSION

The data obtained during this study demonstrates a high prevalence rate (31%) of metabolic syndrome among obese children attending paediatric clinic in HUSM, which is comparable to findings from other studies in developed countries. In view of the alarming presence of components of metabolic syndrome even in children less than 10 years of age, efforts aimed at the prevention of childhood obesity in the community should be stepped up.

CHAPTER 1: INTRODUCTION

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1.1 Background

According to the World Health Organization's (WHO) Interim Report of the Commission on Ending Childhood Obesity 2015, an estimated 42 million children worldwide in 2013 are overweight or obese, with 18 million of these children in Asia(1). This is a problem of rapidly increasing magnitude even in developing countries especially in urban areas.

In Malaysia, the Ministry of Health's National Health and Morbidity Survey (NHMS) 2015 Factsheet(2) shows an alarming surge in the proportion of children less than 18 years who are obese from 3.9% (0.3 million) in 2011 to 11.9% (1 million) in 2015. Without prompt intervention, childhood obesity will track into adulthood (3-5), leading to the development of myriad complications which increase morbidity and mortality, reduce life expectancy and quality of life.

Metabolic syndrome is a constellation of metabolic derangements consisting of abdominal obesity, dyslipidemia, hypertension and raised plasma glucose(6, 7) that significantly increases the risk of developing Type 2 diabetes and premature arteriosclerotic cardiovascular disease.

1.2 Paediatric Metabolic syndrome

Paediatric metabolic syndrome has been noted to have an increased prevalence in obese adolescents with rates as high as 28.7% (3) according to data from the US National Health and Nutrition Examination Survey 1988-1994. Unfortunately, no single unified definition for paediatric metabolic syndrome has been adopted until the formulation of the International Diabetes Federation Consensus Definition in 2005. It is vital that this condition is diagnosed early to enable the prompt institution of early childhood lifestyle interventions to prevent progression and development of complications.

1.3 Literature Review

A search of relevant literature was conducted using Pubmed and Google Scholar which revealed a number of articles of interest including some published locally.

In 2003, Cook, Weitzman et al. 2003, published data from the US National Health and Nutrition Examination Survey (NHANES) conducted between 1988-94 involving 2430 patients aged 12-19 years which determined that while risk factors for metabolic syndrome tended to cluster in obese adolescents, 31.4% of participants with BMI <85th percentile had one risk factor for metabolic syndrome. In overweight adolescents (BMI 85-95th percentile), 54.4% and 23.2% respectively had 1 and 2 risk factors for metabolic syndrome in comparison with obese adolescents (BMI>95th percentile), which were 88.5% and 56% respectively. Plasma glucose levels in overweight participants were also higher than those in obese participants (4.5%, 95% CI: 0-9.5 vs 2.6%, 95% CI: 0-6.3). Among the conclusions the authors arrived at was that waist circumference was a more sensitive indicator of central fat distribution, the essential component of metabolic syndrome, compared to BMI. Unfortunately, paediatric metabolic syndrome had not yet been properly defined at the time this study was conducted in 2003, causing the researchers to base their diagnosis of metabolic syndrome on the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria, which were extrapolated from the adult population. The cross sectional nature of this study also limited the conclusions that could be drawn from it with regards to the causation and progression of paediatric metabolic syndrome.

Weiss et al(8), applied similar criteria to a wider age group of 439 children aged 4-20 years in 2004. The prevalence of metabolic syndrome as determined from their study was 38.7% in moderately obese (BMI>95th percentile) vs 49.7% in severely obese (BMI>98th percentile) children, respectively. Comparison of the various elements of metabolic syndrome such as high plasma glucose, triglycerides, systolic blood pressure and low HDL was also carried out between overweight and obese groups and were found to increase (or decrease in the case of HDL) with increasing BMI. It can therefore be surmised that the prevalence of metabolic syndrome increased with increasing obesity, and was higher in obese compared to

overweight subjects. Subjects followed up by the authors in 2 years continued to demonstrate persistence and progression of the phenotype for metabolic syndrome, with development of type 2 diabetes in 8 patients. Unfortunately, most of the analysis carried out by the authors focussed on moderately and severely obese subjects. Conclusions comparing overweight and obese children had to be independently inferred.

A review article by the same author (9) stressed on the importance of a thorough history and clinical examination to locate clues for the identification of children at risk of developing metabolic complications of childhood obesity stemming from insulin resistance. The importance of assessment of the degree of visceral adiposity in view of its association with increased metabolic risk was emphasized. The author also reminded clinicians to maintain a high index of suspicion for clinically silent conditions such as impaired glucose tolerance and non-alcoholic fatty liver disease, which may be present in this group of high risk children.

Several local researchers have also explored the prevalence of metabolic syndrome in the paediatric population. Quah et al (10) conducted a study on 78 schoolchildren aged 8-10 years old from Kuala Lumpur in 2010. They found that 17.9% of participants can be classified as obese, with a prevalence of metabolic syndrome by IDF 2005 criteria of 2.9% of obese participants. The relatively low prevalence of metabolic syndrome even in obese subjects in comparison with foreign studies was attributed to the high cut-off values used by the IDF criteria. Comparison of obese with normal weight children was also carried out, and it was found that 9.1% of normal weight children had 1 risk factor for metabolic syndrome, which was unfortunately not specified. Additionally, the lack of local waist circumference percentile charts at the time this study was carried out, considering that abdominal adiposity is an essential component of the IDF 2005 criteria for metabolic syndrome may have hampered this study. Another aspect that we hope to improve on in our study is the relatively narrow age range (8-10 years) of this study's participants.

Wee (11) and colleagues examined 402 participants aged 9-12 years in Kuala Lumpur for the risk factors of metabolic syndrome and determined the prevalence of overweight/obesity at 5.3%. Subjects with metabolic syndrome by IDF 2005 criteria

comprised 5.3% of obese participants which is still lower compared to previously conducted US studies. 88% of obese participants had at least 1 risk factor for metabolic syndrome, while 14% of normal weight had a similar number of risk factors. Comparison between overweight and obese subjects was not carried out in this study. The researchers also calculated the prevalence of metabolic syndrome solely in overweight/obese participants. This study was also unable to refer to age/gender specific local waist circumference standards. The authors attributed the lack of association between age, gender and ethnicity with metabolic syndrome to the study's small sample size.

The study conducted by Fadzlina et al (12) in 2014 on 1014 schoolchildren revealed that 25.4% or 258 of the subjects were overweight/obese. Of these, 16% were in the overweight group while 9.4% were in the obese group. Prevalence of metabolic syndrome by IDF 2005 criteria was 2.6% of the general population and 10% of overweight/obese participants. Comparison of overweight/obese with normal weight subjects showed that the risk factors for metabolic syndrome were predominantly clustered in the overweight/obese group. The limitation of this study is that it was confined only to children aged 13 years old and comparison of risk factors between overweight and obese children was not included.

Utilizing data from the Kiel Obesity Prevention Study, Danielzik et al (13) had concluded that a higher birth weight was a major determinant in the development of obesity in children, in addition to parental overweight and socioeconomic status. Boney et al (14) had almost similar findings, concluding that maternal gestational diabetes (OR 10.4, 95% CI: 1.5-74.4) and a large for gestational age birth weight (OR 4.3, 95% CI: 1.5-11.9) were associated with the development of insulin resistance, and subsequently metabolic syndrome in childhood. On the other hand, Rossi et al (15) found no significant difference in the birth weights of obese children in comparison with normal children or any association between those born small for gestational age and the development of future obesity.

Madeira and colleagues (16) studied the impact of obesity on the components of metabolic syndrome in prepubertal children aged 2-11 years and reported a predictable decrease in HDL cholesterol and other anti-atherogenic markers in overweight and obese children in comparison with normal weight children. Hyperinsulinemia and indices of insulin

resistance were also found to be significantly higher in overweight and obese children. Another study conducted by Ferreira et al (17) demonstrated a positive association between insulin resistance and risk factors for the development of cardiovascular disease. The authors reported that metabolic syndrome was only diagnosed in obese children, and that the frequency of metabolic syndrome and number of its components increased with worsening degree of insulin resistance. In contrast with other studies, Ferreira also noted a more significant Spearman correlation coefficient between BMI and development of metabolic syndrome (r=0.77) in comparison with waist circumference (r=0.7).

1.4 Study Rationale

This study aims to compare the clinical and biochemical profile of metabolic syndrome in obese children less than and more than 10 years of age attending paediatric clinic HUSM and determine if there are any significant differences in the clinical and biochemical parameters among these two groups. Body mass index is a less sensitive indicator of abdominal adiposity in comparison with waist circumference as it does not account for body fat distribution. Children with lower BMI but with greater waist circumference is at higher risk of having metabolic syndrome compared to a child with higher BMI but lower waist circumference.

The cut-off point of age of 10 years was chosen as it is the average age of onset of puberty (18, 19) in both sexes in lieu of formal pubertal assessment in the form of Tanner staging. Puberty is associated with increased insulin resistance, which is the primary pathophysiologic mechanism for the development of metabolic syndrome. Therefore, it is hoped that this study will be able to demonstrate if there is any significant difference in the outcomes which predict predisposition to metabolic syndrome between these two groups of obese children.

In addition, it is also hoped that this study will contribute to the available pool of local data on obesity in the paediatric population. This will help determine the magnitude of this problem locally and guide the optimal utilization of available local healthcare resources. By recording the demographic characteristics and clinical and biochemical parameters in these

children, it will lead to a standardized clinical approach for the assessment of a child presenting with obesity.

CHAPTER 2: OBJECTIVES

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2.1 General Objective

To determine if there is a significantly different clinical and biochemical profile of metabolic syndrome between obese children below and above 10 years attending Paediatric Clinic HUSM from 2006-2015

2.2 Specific Objectives:

1. To compare the clinical and biochemical profiles of metabolic syndrome in obese children below and above 10 years attending Pediatric Clinic HUSM between 2006-2015
2. To determine if different age groups in obese children lead to significantly different outcomes with regards to the clinical and biochemical risks for development of metabolic syndrome

2.3 Research Hypothesis

There is a significantly differences in the clinical and biochemical profile of metabolic syndrome in obese children below and above 10 years attending Pediatric Clinic HUSM between 2006-2015

CHAPTER 3: METHODOLOGY

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3.1 Study Design

Retrospective study

3.2 Study Setting

Paediatric Clinic Hospital Universiti Sains Malaysia

3.3 Study population

Reference population – Obese children <18 years old in Kelantan

Source population – Obese children <18 years old followed up at paediatric clinic HUSM

Target population- Overweight and obese children <18 years old followed up at paediatric clinic HUSM from 2006-2015

Sampling frame – List of overweight and obese patients followed up at paediatric clinic HUSM from 2006-2025 obtained with the assistance of HUSM record office

3.4 Sample Size Calculation

Sample size estimation for objective 2

Sample size is calculated using Power and Sample size Calculations v3.0 © Dupont & Plummer using 2 proportion (Pocock) formula for each of the studied variables with

$\alpha = 0.05$ (95% confidence interval)

Power of study=0.8

m=1

1. Waist circumference >90th percentile

Cook et al	
	Overweight,n= 366
WC>90th percentile	11.5%

$P_1 = 0.9$

$P_0 = 0.745$

Calculated sample size, n= 94

2. Systolic blood pressure >130mmHg

Fadzlina et al	
	Non-obese, n=756
SBP>130mmHg	1.19%

$P_1 = 0.3$

$P_0 = 0.1395$

Calculated sample size, n= 103

3. Diastolic blood pressure > 90mmHg

Fadzlina et al	
	Non-obese, n= 756
DBP> 90mmHg	3.17%

$P_1 = 0.25$

$P_0 = 0.1007$

Calculated sample size, n= 101

4. Fasting plasma glucose > 5.6mmol/L

Wee et al	
	Normal weight, n=193
FPG>5.6mmol/L	5.2%

$P_1 = 0.18$

$P_0 = 0.058$

Calculated sample size, n= 109

5. HDL-Cholesterol < 1.03mmol/L

Cook et al	
	Overweight,n= 366
HDL-C<1.03mmol/L	32.3%

$P_1 = 0.7$

$P_0 = 0.5$

Calculated sample size, n= 93

6. Triglycerides >1.24mmol/L

Cook et al	
	Overweight,n= 366
TG>1.24mmol/L	33.5%

$P_1 = 0.72$

$P_0 = 0.518$

Calculated sample size, n= 90

7. Age 12-19 years

Wang & Beydoun et al	
	Overweight
Age 12-19 years	34.3%

$P_1 = 0.343$

$P_0 = 0.174$

Calculated sample size, n= 104

8. Male sex

Wang & Beydoun et al	
	Overweight
Males	34.8%

$P_1 = 0.348$

$P_0 = 0.182$

Calculated sample size, n= 110

9. Small for gestational age (SGA)

Danielzik et al	
	Overweight, n=161
SGA	3.3%

$P_1 = 0.2$

$P_0 = 0.043$

Calculated sample size, n= 67

10. Large for gestational age (LGA)

Danielzik et al	
	Overweight, n=161
LGA	19.6%

$P_1 = 0.6$

$P_0 = 0.37$

Calculated sample size, n= 73

11. Physical activity < 1 hour/day

Danielzik et al	
	Overweight, n=161
Activity<1hour/day	41.4%

$P_1 = 0.55$

$P_0 = 0.33$

Calculated sample size, n= 81

In conclusion, the required sample size for objective 2 is: 110 subjects

3.5 Sampling Methods

No sampling method applied

3.6 Study Subjects

3.6.1 Inclusion criteria

All children aged <18 years old on Paediatric clinic follow up for obesity (BMI >95th centile for age & sex based on CDC growth charts) at HUSM between 2006-2015

3.6.2 Exclusion criteria

1. Underlying syndrome/disease or use of medications affecting body fat composition/distribution e.g. Cushing's, hypothyroidism, Prader willi

2. Use of medication which may alter body glucose/lipid metabolism and/or antihypertensives

3.6.3 Operational definitions

1. Overweight: BMI >85th percentile and <95th percentile for age and sex according to CDC growth chart

2. Obesity: BMI at or >95th percentile for age and sex according to CDC growth chart

3. Hypertension: Systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) that is ≥95th percentile for gender, age, and height

4. Diabetes: fasting plasma glucose level of >6.9 mmol/L or random plasma glucose level of >11.1 mmol/L

5. Impaired glucose tolerance: plasma glucose level 2 hours after a 1.75g/kg (maximum 75g) oral glucose challenge of 7.77-11.1 mmol/L

6. Impaired fasting glucose: fasting plasma glucose level of 5.6-6.9 mmol/L

7. Metabolic syndrome: **Abdominal Obesity**: Waist circumference > 90th centile with **2 OR more** of the following:

    - Serum triglyceride > 1.7mmol/L
    - HDL < 1.03mmol/L
    - SBP > 130mmHg or DBP> 85mmHg
    - FBS > 5.6mmol/L

Age Group (years)	Abdominal Obesity (waist circumference)	Triglycerides	HDL-Cholesterol	Blood pressure	Glucose
6 to <10 years	>90th centile	Excluded due to insufficient data but strong message for weight reduction in patients with WC >90th centile			
10 to <16 years	>90th centile	>1.7mmol/L		Systolic >130/ Diatolic >85mmHg	>5.6mmol/L
>16 years	>94cm for men, >80cm for women	>1.7mmol/L	<1.03 mmol/L in males, <1.29 mmol/L in females	Systolic >130/ Diatolic >85mmHg	>5.6mmol/L

Variable Definition

Quantitative Variables	**Categorical Variables**
Waist circumference>90th percentile for age & sex	Age
High systolic blood pressure>130mmHg or diastolic blood pressure >85mmHg	Sex
Triglycerides>1.7mmol/L	Small for gestational age (SGA)
HDL-Cholesterol<1.03mmol/L	Large for gestational age (LGA)
Fasting blood sugar >5.6mmol/L	Physical activity

3.7 Research Tool

Refer appendix 1 for study Proforma/Data collection sheet

3.8 Study Procedure

Patients under 18 years old who are undergoing or who have previously been followed up at Paediatric clinic HUSM for overweight or obesity over a 10-year period from 2006 to 2015 are identified with the assistance of the HUSM record office. The patient folders are traced and the patients' demographic, anthropometric, clinical and biochemical parameters are reviewed. Subjects who do not fulfil the inclusion criteria or with incomplete data are excluded. The clinical and biochemical profile of eligible subjects are then anonymously recorded in a printed research form.

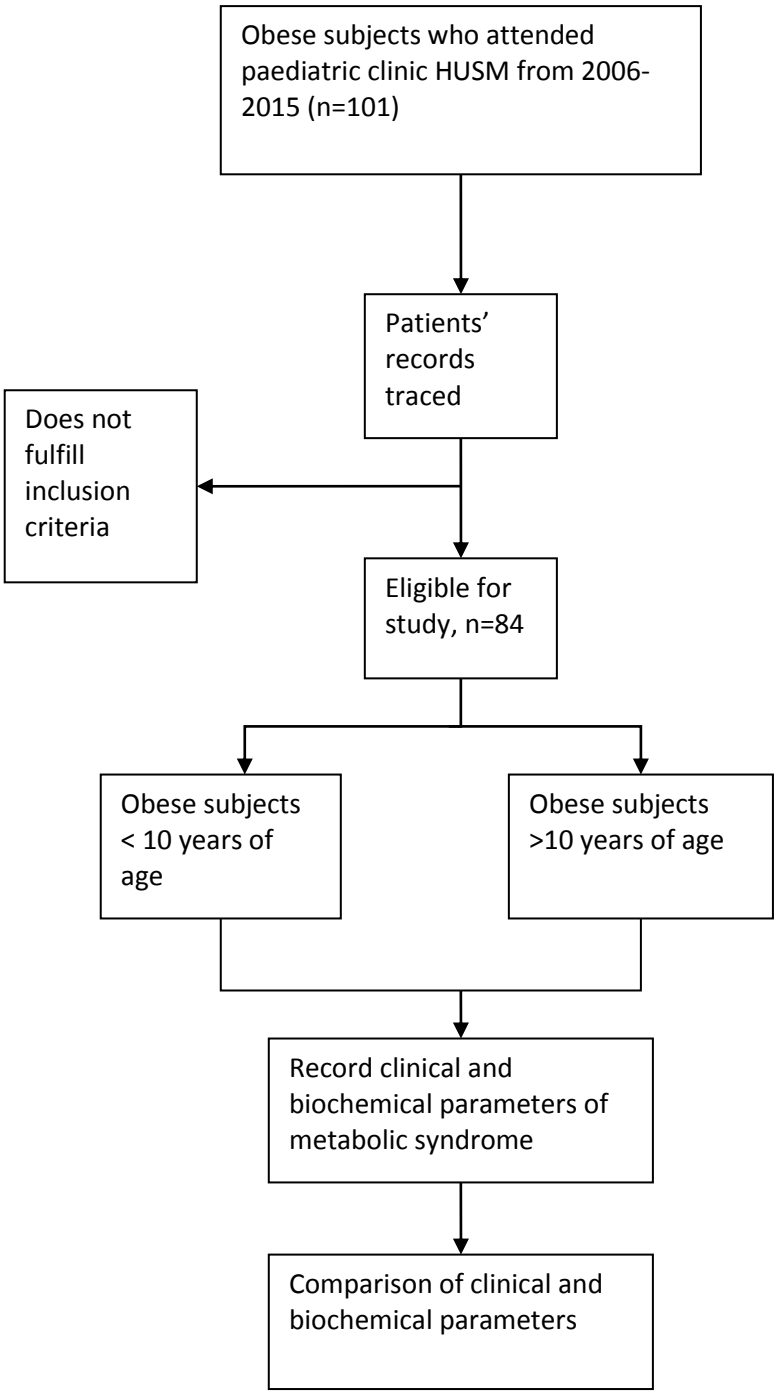

Fig 3.1: Flow Chart of Study

3.9 Statistical Analysis

Data will be entered and analysed using SPSS (IBM) version *22*. Descriptive statistics will be used to summarise the socio-demographic characteristics of subjects. Numerical data will be presented as mean (SD) or median (IQR) based on their normality distribution. Categorical data will be presented as frequency (percentage).

To test association between two categorical variables, statistical analysis will be carried out with either chi square test, while independent T test or Mann –Whitney test is used to compare means. Association between two categorical variables with small sample size (<50 subjects) will be tested with Fischer Exact test.

If the data shows irregular or non-normal distribution, a non-parametric test (Mann Whitney test) will be applied.

3.10 Ethical Approval

This study was approved by the Human Research Ethics Committee (HREC) USM (JEPeM code: USM/JEPeM/16040165)

Refer appendix 2

CHAPTER 4: RESULTS

CHAPTER 4: RESULTS

4.1 Demographic Data

A total of 101 subjects were identified with the assistance of the medical records department to have been followed up at Paediatric clinic HUSM for obesity from 2006 to 2015. However, only 84 of the patient records retrieved were eligible for the study, hence the final sample size of 84 subjects. The available patients were divided into 2 groups, Group 1 consisting of obese children below 10 years of age, and Group 2 which comprising those 10 years of age and above. The demographic characteristics of both groups are tabulated below **(Table 4.1)** and illustrated in **Figure 4.1-4.11. (See Appendix 3-8).**

Of the 84 available subjects, the majority in both age groups were boys, 68.2% in group 1 and 62.8% in group 2 respectively. Mean age of subjects was 9.69 years. Almost similar numbers of subjects in both age groups (18 vs 19) had a first degree relative or parent with obesity. It is also of note that an almost equal number of children below 10 years, in comparison with those more than 10 years, have already been brought to medical attention for obesity. Of equal concern is the almost equal number of subjects in both groups (11 vs 12) who fulfil the IDF criteria for metabolic syndrome. As would be expected, the mean body mass index, waist circumference, systolic blood pressure, and serum triglyceride levels are significantly higher in children >10 years of age. There were no significant differences in birth weight, diastolic blood pressure, total cholesterol, HDL cholesterol, LDL cholesterol or fasting plasma glucose levels. While subjects were distributed normally by age, other clinical and biochemical parameters studied did not show normal distribution, either as a whole or when divided into their respective groups. These parameters were therefore tested by the Mann Whitney U test and the findings and are tabulated below **(Table 4.2)**.

Table 4.1 DEMOGRAPHIC, CLINICAL AND BIOCHEMICAL CHARACTERISTICS BY AGE GROUP

Variables	Below 10 years of age (Group 1) n= 41 (48.8%) Mean (SD)	10 years and above of age (Group2) n= 43 (51.2%) Mean (SD)	Overall n= 84 Mean (SD)	Independent T-test p value (95% CI)
Gender Male Female	 28 (68.2%) 13 (31.7%)	 27 (62.8%) 16 (37.2%)	 55 (65.5%) 29 (34.5%)	
Age (years)	6.89 (2.28)	12.37 (1.51)	9.69 (3.36)	
With Metabolic Syndrome	11 (26.8%)	12 (27.9%)	23 (27.4%)	
Family History of Obesity	18 (43.9%)	19 (44.1%)	49 (58.3%)	
Birth weight (kg)	3.05 (0.72)	3.17 (0.8)	3.11 (0.75)	0.519 (-0.49 to 0.25)
BMI (kg/m^2)	30.3 (6.7)	34.48 (6.74)	32.44 (7.0)	<0.01 (-7.09 to -1.26)
Waist circumference (cm)	90.36 (13.16)	104.8 (19.24)	98.12 (18.08)	<0.01 (-23.6 to -5.29
Systolic BP (mmHg)	107.08 (19.79)	119.93 (16.53)	113.66 (19.2)	<0.01 (-20.8 to -4.85)
Diastolic BP (mmHg)	75 (12.44)	76.84 (10.78)	75.94 (11.59)	0.477 (-6.94 to 3.27)
Triglyceride (mmol/L)	1.32 (0.61)	1.66 (0.82)	1.49 (0.74)	0.037 (-0.65 to -0.02)
HDL-C (mmol/L)	1.16 (0.46)	1.09 (0.26)	1.12 (0.37)	0.475 (-0.12 to 0.24)
Total Cholesterol (mmol/L)	4.61 (1.03)	5.21 (1.9)	4.91 (1.55)	0.082 (-1.26 to 0.08)
LDL-C (mmol/L)	2.88 (0.89)	3.39 (1.88)	3.14 (1.5)	0.163 (-1.23 to 0.21)
Fasting plasma glucose (mmol/L)	4.63 (0.69)	5.25 (2.39)	4.95 (1.8)	0.118 (-1.39 to 0.16)

Table 4.2: MEDIAN CLINICAL AND BIOCHEMICAL PARAMETERS BY AGE GROUP

Parameters	Below 10 years of age (Group 1) n= 41 (48.8%) Median (IQR)	10 years and above of age (Group2) n= 43 (51.2%) Median (IQR)	Z-statistic	Mann Whitney p-value
Birth weight (kg)	3.05 (0.875)	3.0 (0.8)	-0.031	0.975
BMI (kg/m^2)	28.7 (8.2)	33.1 (9.1)	-3.168	0.002
Waist circumference (cm)	90 (18.5)	99 (21.1)	-3.029	0.002
Systolic BP (mmHg)	110.5 (20.25)	122 (21)	-3.078	0.002
Diastolic BP (mmHg)	75 (18.75)	77.5 (16.25)	-0.6	0.549
Triglyceride (mmol/L)	1.16 (0.72)	1.52 (0.88)	-2.205	0.027
HDL-C (mmol/L)	1.06 (0.34)	1.03 (0.32)	-0.234	0.815
Total Cholesterol (mmol/L)	4.38 (1.03)	4.91 (1.67)	-1.971	0.049
LDL-C (mmol/L)	2.83 (0.95)	2.98 (1.4)	-1.129	0.259
Fasting plasma glucose (mmol/L)	4.65 (1)	4.7 (0.6)	-0.498	0.619

Chi square test was used to determine if there were any significant differences between the two studied age categories with regards to the various clinical **(Table 4.3)** and biochemical **(Table 4.4)** parameters recorded in this study, which were converted to categorical variables. There were no significant differences in the proportion of subjects in both age groups with BMI>97^{th} percentile or hypertension (systolic and/or diastolic blood pressure ≥95th percentile for gender, age, and height). The only significant association found

was between age category and total cholesterol level (X^2 6.276, p 0.012). There was no significant association between age category and serum triglyceride, HDL cholesterol, LDL cholesterol, or fasting blood sugar levels. Additionally, there were no significant differences in the number of obese children with metabolic syndrome between the two age categories (X^2 0.012, p 0.912). There were also no significant differences in the gender distribution of obese children in both age categories (X^2 0.281, p 0.596).

Table 4.3: COMPARISON OF CLINICAL PARAMETERS BY AGE CATEGORY

	Age <10 years	Age ≥10 years	X^2 (df)	p-value Chi-square	p-value Fisher exact
Gender (n=84) Male Female	 28 (68.3%) 13 (31.7%)	 27 (68.3%) 16 (37.2%)	0.28 (1)	0.596	0.651
Hypertension (n=82) Yes No	 23(56.1%) 18(43.9%)	 26 (60.5%) 17 (39.5%)	0.33 (1)	0.796	0.637
BMI (n=84) <97th percentile >97th percentile	 2 (5%) 38 (95%)	 3 (6.9%) 40 (93.1%)	0.004 (1)	0.912	1
Metabolic synd Absent Present	 30 (73.2%) 11 (26.8%)	 31 (72.1%) 12 (27.9%)	0.012 (1)	0.0912	1