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Prevalence, Characteristics and Correlates of Prediabetes in Al Ain and Dubai, the UAE: Cross Sectional Study

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PREVALENCE, CHARACTERISTICS AND CORRELATES OF PREDIABETES IN AL AIN AND DUBAI, THE UAE: CROSS SECTIONAL STUDY

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This dissertation is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Under the Supervision of Professor Syed M. Shah

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Declaration of Original Work

I, Layla Mohamed Al Marzooqi, the undersigned, a graduate student at the United Arab Emirates University (UAEU), and the author of this dissertation, entitled "*Prevalence, Characteristics and Correlates of Prediabetes in Al Ain and Dubai, the UAE: Cross Sectional Study*", hereby, solemnly declare that this dissertation is my own original research work that has been done and prepared by me under the supervision of Professor Syed M. Shah, in the College of Medicine and Health Sciences at UAEU. This work has not previously been presented or published, or formed the basis for the award of any academic degree, diploma or a similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my dissertation have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation and/or publication of this dissertation.

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Abstract

The United Arab Emirates (UAE) has one of the highest rates of type 2 diabetes mellitus in the world. Prior to the onset of type 2 diabetes mellitus, a period of moderate hyperglycemia is often present, referred to as prediabetes. This is associated with a significant loss of pancreatic beta cells, an increased risk of cardiovascular disease and other serious health issues. There are gaps in the literature concerning the prevalence of prediabetes and its associated correlates, as well as correlations between the conversion rates from prediabetes to type 2 diabetes mellitus.

The primary objective of this study was to determine the prevalence of prediabetes and its correlates in adults. The secondary objective was to identify the proportion of conversions of prediabetes to type 2 diabetes mellitus and the major correlates.

This research was based on secondary data collected during prediabetes interventions in Al Ain and Dubai, two cities in the UAE. In Al Ain, a random sample (n=605) of parents participated in type 2 diabetes mellitus screening in a family-based study. In Dubai, 700 Emirati adults diagnosed with prediabetes, at five primary health care centers, were invited to take part in the intervention study. After ethical approval and gaining informed consent, socio-demographic, anthropometric, lifestyle and clinical data were then collected. Prediabetes and type 2 diabetes mellitus were defined in accordance with the American Diabetes Association's guidelines: based on fasting plasma glucose (FPG ≥126 mg/dl (≥7 mmol/l) for type 2 diabetes, 110-125 mg/dl (6.1-7 mmol/l) for prediabetes, (HbA1c ≥6.5%) for type 2 diabetes and (HbA1c 5.7-6.4%) for prediabetes.

We used a multivariable multinomial logistic regression analysis to identify the independent correlates for prediabetes and type 2 diabetes mellitus in comparison to people with normal glucose levels in Al Ain. In Dubai we used logistic regression analysis to identify the correlates of the transition from prediabetes to DM in the data from the various health centers.

The overall prevalence of prediabetes and type 2 diabetes mellitus was 37.7% and 18.7%, respectively, in Al Ain. Ageing, being overweight and obesity were positive correlates for prediabetes. A secondary school, or higher, level of education correlated

negatively for prediabetes. Ageing, obesity, central obesity, a lack of vigorous physical activity and a family history of diabetes were positively correlated for diabetes, while a secondary school, or higher, level of education, were negative correlates for diabetes.

In Dubai, a significant proportion (23%) of participants with prediabetes suffered from DM within a two-year period. Low HDL-cholesterol was significantly (<0.05) correlated with a deterioration from prediabetes to type 2 diabetes mellitus. Subjects who reported vigorous physical activity at least once a week were less likely to acquire type 2 diabetes mellitus.

Prediabetes is a significant public health problem in the UAE. Old age, being overweight, obesity and educational levels were all found to be significant correlates for prediabetes. A high proportion of people with prediabetes acquired type 2 diabetes mellitus within a relatively brief period. This highlights the importance of both screening and intervention in the case of prediabetes. Our findings were consistent with previous studies carried out in other countries.

Keywords: Prediabetes, type 2 diabetes mellitus, obesity, prediabetes screening, physical activity, prediabetes-to-type 2 diabetes, UAE.

Title and Abstract (in Arabic)

دراسة مقطعية حول معدل الانتشار والخصائص والعوامل المؤدية إلى مرض ما قبل السكري في مدينتي العين ودبي، دولة الإمارات العربية المتحدة

الملخص

المقدمة: تشير التقارير العالمية إلى أن دولة الإمارات العربية المتحدة تعاني من ارتفاع كبير في معدلات انتشار مرض السكري من النوع الثاني. غالباً ما يعاني الأشخاص من ارتفاع في نسبة السكر في الدم عن المعدل الطبيعي وذلك قبل تشخيص مرض السكري من النوع الثاني، تسمى هذه المرحلة بمرض ما قبل السكري. حيث ترتبط هذه المرحلة بفقدان عدد كبير من خلايا البيتا المتواجدة في البنكرياس، وبزيادة في نسبة الإصابة بأمراض القلب والأوعية الدموية وغيرها من التداعيات الصحية الخطيرة. بالرغم من ذلك فهناك نقص كبير في عدد الدراسات التي أجريت حول أسباب انتشار مرض ما قبل السكري والعوامل المرتبطة به ومسببات تطوره إلى مرض السكري من النوع الثاني.

هدف الدراسة: الهدف الأساسي من هذه الدراسة هو تحديد مدى انتشار مرض ما قبل السكري والعوامل المسببة له. أما الهدف الثاني فهو تحديد المسببات الرئيسية لتطور المرض من مرحلة ما قبل السكري إلى مرض السكري من النوع الثاني ونسبة هذا التحول.

المنهج المتبع للدراسة: استند هذا البحث على بيانات ثانوية، تم تجميعها خلال دراسة أخرى أجريت في مدينتي العين ودبي في الإمارات العربية المتحدة للحد من خطر مرحلة ما قبل السكري. تمت دعوة عينة عشوائية (عدد=605) من أولياء أمور طلاب المدارس الذين شاركوا في الدراسة المعنية بفحص نسبة انتشار مرض ما قبل السكري في مدينة العين. أما في مدينة دبي فتمت دعوة 700 شخص إماراتي تم تشخيصهم سابقاً بمرض ما قبل السكري، في خمسة مراكز للرعاية الصحية الأولية التابعة لهيئة الصحة بدبي للمشاركة في الدراسة. تم جمع بيانات خاصة بهم ومتعلقة بالحالة الاجتماعية والبدانة والنشاط البدني وقياس مدى خطر إصابتهم بمرض انقطاع التنفس أثناء النوم عن طريق استخدام استبيان برلين لقياس توقف التنفس أثناء النوم. علماً بأنه تم تحديد نسبة مرض ما قبل السكري والسكري من النوع الثاني وفقاً لتعريف الجمعية الأمريكية للسكري، وذلك استناداً على نسبة السكر في حالة الصيام (110-125 ملغ/ديسيلتر لمرض ما قبل

السكري و ≥126 ملغ/ديسيلتر لمرض السكري من النوع الثاني) ومعدل السكر التراكمي (5.7-6.4٪ لمرحلة ما قبل السكري و ≥6.5٪ لمرض السكري من النوع الثاني).

تم استخدام نموذج الانحدار اللوجستي المتعدد لتحديد العوامل المرتبطة بمرض ما قبل السكري والسكري من النوع الثاني عبر المقارنة بأشخاص يتمتعون بمستوى سكر طبيعي في مدينة العين. أما البيانات المأخوذة من مراكز هيئة الصحة في دبي فتم تحليلها باستخدام نموذج الانحدار اللوجستي ثنائي الاستجابة لتحديد مسببات التطور من مرحلة ما قبل السكري إلى مرض السكري من النوع الثاني في مدينة دبي.

نتائج الدراسة: بلغت نسبة انتشار مرضي ما قبل السكري والسكري من النوع الثاني في مدينة العين 37.7٪ و18.7٪ على التوالي. كما أظهرت نتائج الدراسة ارتباطاً إيجابياً بين مرض ما قبل السكري وكل من التقدم في العمر، وزيادة الوزن والبدانة ($P<0.05$) كما ارتبط مرض ما قبل السكري سلباً بمستوى التعليم (الثانوي والتعليم العالي).

أما بيانات مدينة دبي فقد أظهرت أن نسبة كبيرة (23%) من المشاركين الذين كانوا يعانون من مرض ما قبل السكري أصيبوا بمرض السكري من النوع الثاني خلال السنتين من المتابعة. كما أشارت نتائج الدراسة إلى ارتباط إيجابي بين انخفاض نسبة الكوليسترول عالي الكثافة ($P<0.05$) بخطر التحول من مرض ما قبل السكري إلى مرض السكري من النوع الثاني. وإلى ارتباط هامشي مع معدل السمنة ($P=0.054$). كما أظهرت الدراسة ارتباط النشاط البدني عالي الجهد مع خطر التحول من مرحلة ما قبل السكري إلى السكري من النوع الثاني.

خلاصة الدراسة: يعد مرض ما قبل السكري من أهم التحديات الصحية في دولة الإمارات العربية المتحدة. حيث تشكل زيادة الوزن والسمنة، والتقدم في العمر، عوامل مسببة لمرض ما قبل السكري. وقد لوحظ تطور مرض ما قبل السكري إلى مرض السكري من النوع الثاني لدى نسبة كبيرة من الأشخاص خلال فترة زمنية قصيرة نسبياً. مما يسلط الضوء على أهمية الفحص الدوري والتدخل المبكر لمعالجة مرض ما قبل السكري. وهذا ما أجمعت عليه العديد من الدراسات السابقة في بلدان أخرى.

مفاهيم البحث الرئيسية: مرض ما قبل السكري، السكري من النوع الثاني، البدانة، النشاط البدني، التحول من مرض ما قبل السكري إلى مرض السكري من النوع الثاني، دولة الإمارات العربية المتحدة، معدل السكر التراكمي في الدم.

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Dedication

With love to my husband, children and parents

Table of Contents

Title i
Declaration of Original Work ii
Copyright iii
Advisory Committee iv
Approval of the Doctorate Dissertation v
Abstract vii
Title and Abstract (in Arabic) ix
Acknowledgements xi
Dedication xiii
Table of Contents xiv
List of Tables xviii
List of Figures xix
List of Abbreviations xx
Chapter 1 : Review of Literature 1
1.1 Overview of Prediabetes 1
1.1.1 Pathophysiology of Prediabetes 1
1.1.2 Diagnosis and Screening of Prediabetes 3
1.1.3 Classification of Prediabetes and DM 7
1.1.4 Epidemiology of Prediabetes 8
1.1.5 Correlates of Prediabetes 14
1.1.6 Complications of Prediabetes 17
1.1.7 Screening and Control of Prediabetes 20
1.2 Overview of Obesity and its Role in Diabetes and Prediabetes 22
1.2.1 Definition and Classifications of Obesity 23
1.2.2 Epidemiology of Obesity 27
1.2.3 Correlates for Obesity 30
1.2.4 Consequences of Obesity 39
1.2.5 Association of Obesity with Prediabetes and DM 39
1.3 Summary 41
Chapter 2 : Prevalence of Prediabetes and its Correlates - Al Ain 43
2.1 Aims and Objectives 43
2.1.1 Aims 43
2.1.2 Specific Objectives 43
2.2 Methods 43
2.2.1 Study Design 43

2.2.2 Study Site 43
2.2.3 Study Population 44
2.2.4 Selection of the Study Participants 46
2.2.5 Sample Size Calculation 46
2.2.6 Study Measurement 46
2.2.7 Data Collection Procedure 47
2.2.8 Ethical Considerations 52
2.2.9 Data Analysis 53
2.2.10 Timeline 54
2.3 Results 54
2.3.1 Baseline Demographic Characteristics of the Study Population 56
2.3.2 Baseline Clinical Characteristics of the Study Population 56
2.3.3 Baseline PA Level 58
2.3.4 Prevalence of DM and Prediabetes 58
2.3.5 Prevalence of Overweight/ Obesity 60
2.3.6 Number of People Diagnosed with Prediabetes and DM 65
2.3.7 Association between Prediabetes, DM and Age 66
2.3.8 Association between Prediabetes, DM and Education Level 66
2.3.9 Association between Prediabetes, DM and Waist Hip Ratio 66
2.3.10 Association between Prediabetes, DM and Obesity 67
2.3.11 Association between Prediabetes, DM and Smoking 67
2.3.12 Association between Prediabetes, DM and TGs Levels 67
2.3.13 Association between Prediabetes, DM and Physical Activity 67
2.3.14 Association between Prediabetes, DM and a Family History of DM 68
2.4 Discussion 68
2.4.1 Prevalence of Prediabetes 68
2.4.2 Association between Prediabetes and Age 70
2.4.3 Association between Prediabetes and Obesity 71
2.4.4 Association between Prediabetes and Educational Level 75
2.4.5 Prevalence of DM 76
2.4.6 Association between DM and Age 77
2.4.7 Association between DM and Education Level 77
2.4.8 Association between DM and Waist Hip Ratio 77
2.5 Strengths of Our Study 78
2.6 Limitations of Our Study 79

Chapter 3 : Characteristics of Prediabetes and Correlates of Conversion from Prediabetes to DM in Dubai, the UAE 80
3.1 Introduction 80
3.1.1 Secondary Aims and Objectives 81
3.2 Methods 82

3.2.1 Study Design 82
3.2.2 Study Site 82
3.2.3 Study Population 82
3.2.4 Sample Size and Selection of Study Participants Correlate 83
3.2.5 Study Measurement 85
3.2.6 Data Collection Procedure 85
3.2.7 Ethical Considerations 90
3.2.8 Timeline 90
3.2.9 Data Analysis 90
3.3 Results 91
3.3.1 Baseline Demographic and Clinical Characteristics of the Study Population 93
3.3.2 Follow-Up on PA Levels 93
3.3.3 Follow-up on Fruit and Vegetable Consumption 94
3.3.4 Follow-Up on Sleep Apnea 95
3.3.5 Rate of Conversion of Prediabetes to DM 96
3.3.6 Association between Independent Variables and Conversion from Prediabetes to DM 96
3.3.7 Association between DM and Age 99
3.3.8 Association between DM and Marital Status 100
3.3.9 Association between DM and Educational Level 100
3.3.10 Association between DM and Physical Activity 101
3.3.11 Association between DM and Hypertension 101
3.3.12 Association between DM and Cholesterol and HDL-Cholesterol Levels 101
3.3.13 Association between DM and Other Associates 102
3.4 Discussion 102
3.4.1 Rate of Conversion of Prediabetes to DM 103
3.4.2 Percentage of Smokers in our Study Population 105
3.4.3 Percentage of People with Sleep Apnea in our Study 106
3.4.4 Physical Activity as a Correlate of Conversion from Prediabetes to DM 106
3.4.5 Lipid Profile as a Correlate of Conversion from Prediabetes to DM 106
3.4.6 Age as a Correlate of Conversion from Prediabetes to DM 107
3.5 Strengths of Our Study 108
3.6 Limitations of our Study 109

Chapter 4 : Conclusion 111
4.1 Overall Summary 111
4.2 Recommendations 113

References 115

List of Publications 128

Appendices 129
Appendix 1: Ethics Approval from Al Ain Medical District Human Research 129
Appendix 2: Ethics Approval from Dubai Health Authority 130
Appendix 3: Berlin Questionnaire 131
Appendix 4: Global Health-Developed Developing Countries Partnership for Non-Communicable Disease Prevention 132
Appendix 5: Developed Developing Countries Partnership for Non-Communicable Disease Prevention 144
Appendix 6: Consent form in Arabic 158
Appendix 7: DM prevention questionnaire 159

List of Tables

Table 1.1: The ADA guidelines for diagnosis of prediabetes and DM (2017) 8

Table 1.2: WHO guidelines for diagnosis of prediabetes and DM (2017) 8

Table 1.3: WHO cut-off points and the risk of metabolic complications 26

Table 1.4: Cut-off values of WC based on ethnicity and gender 27

Table 2.1: Demographic and clinical characteristics of the study population (n=605) in Al Ain, Abu Dhabi, the UAE 55

Table 2.2: Distribution of the study population, according to different measures of obesity 61

Table 2.3: Univariate analyses− unadjusted odds ratios for DM and prediabetes 62

Table 2.4: Multivariable multinomial logistic regression analysis− adjusted odds ratios (AOR) for DM and prediabetes 64

Table 3.1: Demographic and clinical characteristics of the study population (n=487) in Dubai, the UAE 92

Table 3.2: Univariate analyses− unadjusted odds ratios for conversion to DM 97

Table 3.3: Multivariable logistic regression analysis− adjusted odds ratios (AORs) for conversion to DM 99

List of Figures

Figure 1: Summary of primary data collection in Al Ain, Abu Dhabi, the UAE 45

Figure 2: Summary of secondary data collected in Al Ain, Abu Dhabi, the UAE (n=605) for this dissertation 52

Figure 3: The percentage of body mass index categories (n=605), in Al Ain, Abu Dhabi, the UAE 57

Figure 4: The percentage of body mass index categories by gender (n=605), in Al Ain, Abu Dhabi, the UAE 57

Figure 5: Proportion (%) with normoglycemia, prediabetes and DM by gender (n=605), in Al Ain, Abu Dhabi, the UAE..... 58

Figure 6: Prevalence of DM and prediabetes (%) by BMI categories (n=605), in Al Ain, Abu Dhabi, the UAE 59

Figure 7: Prevalence of prediabetes and DM by central obesity (Waist circumference >=94 cm in male >=80 cm in female) (n=605), in Al Ain, Abu Dhabi, the UAE 60

Figure 8: Percentage of participants diagnosed with prediabetes using HbA1c or FPG 65

Figure 9: Percentage of participants diagnosed with DM by a doctor's diagnosis or HbA1c or FBG 65

Figure 10: Study population in Dubai, the UAE (n=487) 83

Figure 11: Percentage of participants, by gender, who are PA (n=487) in Dubai, the UAE 94

Figure 12: Percentage of participants, by gender, who consume fruit and vegetables on a daily basis (n=487) in Dubai, the UAE..... 95

Figure 13: Percentage of participants, by gender, who were found to be at high risk of sleep apnea after using the Berlin Questionnaire (n=487) in Dubai, UAE 96

List of Abbreviations

ADA	American Diabetes Association
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
BP	Blood Pressure
CDC	Center for Disease Control and Prevention
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
DHA	Dubai Health Authority
FBG	Fasting Blood Glucose
GCC	Gulf Cooperation Council
HbA1c	Glycated Hemoglobin
IFG	Impaired Fasting Glucose
IGT	Impaired Glucose Tolerance
IDF	International Diabetes Federation
IPAQ	International Physical Activity Questionnaire
Kg	Kilogram
MENA	Middle East and North Africa
MOH	Ministry of Health and Prevention
NCD	Non-Communicable Disease
NHANES	National Health and Nutrition Examination Survey
OR	Odds Ratio
OGTT	Oral Glucose Tolerance Test
OECD	The Organization for Economic Co-operation and Development

PA	Physical Activity
RDA	Recommended Daily Allowance
PG	Postprandial Glucose
TG	Triglyceride
UAE	United Arab Emirates
USA	United States of America
WC	Waist Circumference
WHR	Waist-Hip Ratio
WHO	World Health Organization

Chapter 1: Review of Literature

1.1 Overview of Prediabetes

Prediabetes is a stage of intermediate hyperglycemia between normal glucose tolerance and type 2 diabetes mellitus (DM), that is observed in the fasting and/ or postprandial stage[1]. Prediabetes not only correlates for future incidences of DM, but also prefigures other non-communicable diseases (NCD).

The concept of prediabetes has been around since the 1950s. From 2000 onwards, the term prediabetes started to be commonly used[2]. Both the World Health Organization (WHO) and the American Diabetes Association (ADA) have used the term 'Intermediate Hyperglycemia' and 'High Risk State of Developing DM' respectively, rather than prediabetes. The term prediabetes has been criticized for many reasons. One of these is that many people with the condition may not eventually develop DM. Furthermore, the term prediabetes could indicate that people with the condition are actually healthy (with no disease currently present) and imply that no intervention is required, despite the fact that prediabetes is a major public health concern and requires early intervention[3].

1.1.1 Pathophysiology of Prediabetes

An important metabolic concern is the disturbance of glucose-insulin homeostasis. Impaired fasting glucose (IFG) or glycaemia refers to elevated glucose levels in a fasting state that are not yet at the level of diabetes. Impaired glucose tolerance (IGT) can be defined by elevated postprandial glucose levels, indicating an impairment in the capacity of the human body to handle consumed carbohydrates. It is evaluated by administering an oral glucose tolerance test (OGTT).

Insulin resistance is where a normal amount of insulin is not enough to yield a predictable glucose response in muscles, the liver, and adipose tissues. A study has shown that genetics plays a role in insulin resistance and this can be worsened by environmental factors, such as obesity (especially central obesity and related visceral fat) and PA[4]. Therefore, interventions that improve insulin resistance and limit the secretary load on beta cells has been proven to prevent prediabetes progressing as far as DM.

The mechanisms for IGT and IFG are different depending on where exactly the body is failing to respond to insulin[5]. For IFG, insulin resistance is mainly located in the liver, while for IGT it is in the muscle[6]. The patterns of insulin resistance for both disorders (IFG and IGT) also differ. Insulin is usually secreted in two stages following a meal, the early and late phases. The early phase occurs 30 to 60 minutes after consumption, while the late phase occurs from 60-120 minutes. Abnormalities in insulin secretion in the early phase lead to IFG and in the later phase they lead to IGT. In people with IGT, muscle tissues are resistant to insulin. Therefore, glucose blood levels remains high for two hours after the meal, despite the fact that they remains normal after fasting overnight and between meals. In people with IFG, blood glucose levels are elevated in the morning and for half an hour after they have eaten food, as the liver will secrete because it is resistant to the insulin. Therefore, in people with IFG, an early insulin response is abnormal while a late insulin response is the norm[7].

Impaired Beta Cells Function

The pancreas is a vital organ consisting of the pancreatic islet, or the islet of Langerhans. These islets are scattered throughout the pancreas. They consist of different cell types, including insulin secreting beta cells, glucagon producing alpha

cells and pancreatic polypeptide producing delta cells[8]. An appropriate beta cell function requires there to be a normal beta cell anatomy, which is essential for an appropriate response to a changeable metabolic need for insulin. Beta cell dysfunction results from there being inadequate glucose sensing that would stimulate insulin secretion. Therefore, elevated glucose concentrations prevail. A constant elevation in the level of glucose above the normal range results in prediabetes. At least a 60% decrease in beta cells is required to develop DM[4]. Beta cell dysfunction is more serious than insulin resistance, as is found in beta cell dysfunction. Insulin secretion is reduced, but can still be secreted even when there is insulin resistance.

Beta cell dysfunction is correlated to the 2-hour plasma glucose level during OGTT in normal glucose tolerant individuals. It is also a correlate for people with normal glucose level becoming IGT and, thus, eventually transitioning to DM. In people with IGT, there is a 70%-80% decline in beta cell function[4]. Therefore, interventions that stop, or delay, the dysfunction of beta cells are valuable tools in fighting DM.

1.1.2 Diagnosis and Screening of Prediabetes

The WHO proposed the term prediabetes as early as 1980, but later discouraged people from using it because slightly increased glucose levels do not always translate into DM. In 2005, the ADA proposed the term prediabetes for impaired glucose tolerance (IGT) and impaired fasting glucose (IFG). However, different cut-off values were used for IFG – 5.6 mmol/l by the ADA[9] and 6.1 mmol/l by the WHO[10]. Thus, different criteria were used in parallel to define prediabetes as an intermediate phase of altered blood glucose concentration between normal glucose levels and DM that was not yet serious enough to be diagnosed as DM comprising of

IFG and IGT[11]. FBG and OGTT were used for the diagnosis of prediabetes by the ADA and the WHO, and lately HbA1c has been added to these criteria[12]. HbA1c refers to glycated hemoglobin, which mirrors overall blood glucose levels present two to three months prior to laboratory testing. A consensus on the diagnostic criteria that defines prediabetes has not yet been agreed[13].

Although the ADA has recommended HbA1c as a diagnostic tool for identifying prediabetic adults at risk of developing DM, several points need to be taken into consideration. Firstly, the ADA considered HbA1c to be a poor diagnostic tool for prediabetes, due to low sensitivity and specificity[14]. Secondly, the accuracy of the HbA1c test to diagnose prediabetes in adults, and its correlation to mean serum glucose concentrations, requires more work to identify how several covariates can influence the HbA1c level in adults. These covariates are age, race/ ethnicity and mineral deficiencies among others)[15].

The ADA recommends that if a diagnostic test needs to be repeated, it is preferable to repeat the same test as there is greater likelihood of an agreement with the initial test result[1]. However, if two different tests have been performed and the results are in conflict regarding a diagnosis of DM, it is the test that yielded the positive result that should be repeated.

In contrast to previous recommendations specifying FBG as the preferred test, new criteria leave the choice of diagnostic test to the physician. In total 19,182 participants, aged ≥12 years, were interviewed in the United States to identify the prevalence of prediabetes. This study utilized HbA1c 5.7-6.4% or FBG 100 to 125 mg/dl: OGTT was not used. Overall, there was an increase in the prevalence of age-adjusted prediabetes from 27.4% in 1999-2002 to 34.1% in 2007-2010 according to

the HbA1c criterion. However, the prevalence of prediabetes, when using IFG with the same population, remained fundamentally unchanged (23.8-25.9%) over the same period[16].

a) Impaired fasting glucose (IFG) and impaired glucose tolerance (IGT)

IFG and IGT are types of prediabetes where the patient's blood sugar level is constantly greater than normal levels, but not high enough for a diagnosis of DM to be made. The ADA's most recent (2010) definition of IFG is a fasting blood sugar level of 5.6-6.9 mmol/l (100 mg/dl to 125 mg/dl - a measurement of 2-hour post load glucose is not recommended). This cut-off point is lower than the one set by the WHO, where the fasting blood sugar is ≥6.1 and <7.0 mmol/l and the 2-hour post load is <7.8 mmol/l (if measured)[16]. The reason the ADA set a lower fasting glucose level is to make the prevalence of IGT and IFG consistent. However, this did not achieve its target and instead led to an approximately three to four-fold increase in the overall prevalence of IFG[17]. In most populations, IFT is more common than IGT. Data from the United States indicates that the prevalence of IFG and IGT is around 26% and 15% respectively[18]. It is predicted that both will rise in the future. Furthermore, the prevalence varies considerably according to a person's age and sex.

The prevalence of IFG, compared to IGT, is higher in older people and among men than it is in women for some unknown reasons[3]. The IFG level tends to incline to a plateau in middle age, while the prevalence of IGT increases in old age. The European Diabetes Epidemiology, a collaborative analysis of diagnostic criteria in Europe, showed a prevalence of IGT that was 2.9% in men aged 30-39 and 15.1% in those aged 70-79[19]. Both IFG and IGT are related to a substantially increased risk of

developing DM, with the highest risk being in people who have combined IFG and IGT[20].

b) Glycated hemoglobin HbA1c

Glycated hemoglobin (also called hemoglobin A1c, HbA1c, A1C or Hb1c) is the product of non-enzymatic glycosylation of hemoglobin β-chains and the measure of glucose bound to the hemoglobin. It is equivalent to the overall level of glucose in the blood over the previous two to three months (which is the lifespan of red blood cells)[21]. Poor glycemic control leads to the elevation of HbA1c levels and vice versa. It has been used to assess glycemic control since 1976[22].

The ADA recommended using the HbA1c 5.7-6.4% test as a method of to diagnose prediabetes in 2015[23]. However, it did not establish firm guidelines for the use of the HbA1c test in adolescents, as their study did not validate thresholds for this group. Research has shown that HbA1c results are affected by a variety of factors influencing glycemic control. These factors are classified as non-modifiable. Modifiable factors include BMI, vitamin D/ iron/ magnesium levels, PA, red cell lifespan, renal and liver function and pregnancy. Non-modifiable factors are age, ethnicity/ race, genetic factors, family history, infection, hormonal and autoimmune conditions. Consequently, the HbA1c test has not been used consistently by clinicians to identify individuals with prediabetes[24].

Using HbA1c for the diagnosis of prediabetes has many advantages. These include the convenience of the test with no need to fast beforehand. It exhibits good stability after specimen collection and also reproducibility (including less day-to-day variability in comparison with either the FBG or 2-hour postprandial glucose level)

and can successfully detect adult individuals at a lower risk of developing DM[24]. The International Expert Committee, appointed by the ADA and the European Association for the Study of DM, has warned of the tests limitations. These are the fact that the HbA1c test is expensive when compared to OGTT, and is not readily available in developing countries.

The committee found that the HbA1c test did not accurately diagnose DM as well as other tests, such as the FBG or OGTT. Therefore, use of HbA1c alone to diagnose DM, or prediabetes, requires that it be translated into a meaningful clinical practice[1], or that a combination of the HbA1C and FBG tests is used in the diagnosis of prediabetes. This can decrease the risk of any systematic bias inherent when testing only with HbA1c[25].

HbA1c has been shown to correlate with the likelihood of diabetic retinopathy and microvascular complications. This continuous linear relationship is even stronger than that of FBG. The ADA and WHO have set a cut-off point for HbA1c of 6.5% as the diagnostic criteria for prediabetes, because retinopathy increases above this level. This is in addition to previous criteria that uses IFG and IGT[26].

1.1.3 Classification of Prediabetes and DM

Current ADA guidelines for the diagnosis of prediabetes and DM[27] are as follows:

Table 1.1: The ADA guidelines for diagnosis of prediabetes and DM (2017)

Categories for diagnosis of prediabetes		
FBG	2-hour post prandial glucose	HbA1c
100-125 mg/dl (5.6-6.9 mmol/l) IFG and	140-199 mg/dl (7.8-11.0 mmol/l) IGT Or	5.7-6.4% (39-46 mmol/mol)
Criteria for DM diagnosis		
≥126 mg/dl (7.0 mmol/l) or	≥200 mg/dl (11.1 mmol/l) during OGTT (75-g) or	≥6.5% (48 mmol/mol) or
Random PG ≥200 mg/dl (11.1 mmol/l)		

Current WHO guidelines for diagnosis of prediabetes and DM[28] are as follow:

Table 1.2: WHO guidelines for diagnosis of prediabetes and DM (2017)

Categories for diagnosis of prediabetes		
FBG	2-hour post prandial glucose	HbA1c
110-125 mg/dl (6.1-6.9 mmol/l) IFG	140 mg/dl (<7.8 mmol/l) IFG	
126 mg/dl (<7.0 mmol/l) IGT	140-200 mg/dl (7.8-11.0 mmol/l) IGT	
Categories for diagnosis of DM		
≥126 mg/dl (7.0 mmol/l)	≥200 mg/dl (11.1 mmol/l)	≥6.5% (48 mmol/mol)

1.1.4 Epidemiology of Prediabetes

The prevalence of prediabetes is increasing worldwide. It is estimated that >470 million people will have prediabetes by 2030, and the highest increase is expected to be in South-East Asia and the Western Pacific Region[3]. The prevalence of prediabetes differs, depending on the criteria used for diagnosis[16]. Studies have shown that only using the FBG level for the diagnosis of prediabetes results in an

underestimate of the scale of the disorder[29]. Therefore, HbA1c remains a useful complimentary tool alongside FBG for the diagnosis of prediabetes[26].

In the United States (USA), the prevalence and emerging trends of prediabetes and DM from 1988-2012 among adults aged 18 and above were described by the National Health and Nutrition Examination Survey. The incidence of DM was identified by using a self-reported diagnosis of DM, or HbA1c (≥6.5%) or FBG (126 mg/dl) or a 2-hour PG (200 mg/dl) if DM had not been previously diagnosed. Furthermore, prediabetes was defined by HbA1c (5.7-6.4%) and FBG (100-125 mg/dl), or a 2-hour PG (140-199 mg/dl). In this study, it was reported that the crude (unadjusted) tally for DM was 14.3% (95% CI 12.2-16.8%). The age-standardized or age-adjusted prevalence of DM increased from 9.8% (95% CI 8.9%-10.6%) in 1988-1994 to 12.4% (95% CI 10.8%-14.2%) in 2011-2012 ($p<0.001$ for trend). Furthermore, DM in the USA increased in all of the age groups, as well as in both sexes and every racial and ethnic group surveyed. In the same study, the crude percentage for prediabetes in adults was 36.4% (95% CI 30.5-42.7%). Moreover, the prevalence of prediabetes was particularly high in Hispanics in the USA[30].

In Canada, the incidence of prediabetes and DM among adults aged 20 and above was estimated using the Canadian Health Measurement Survey (n=3,494)[31], a national population-based sample. Prediabetes and DM were defined by using the Canadian guidelines, based on fasting FBG and HbA1c levels. Prediabetes was defined as an FBG level of ≥6.1 and <7.0 mmol/l or an HbA1c level of ≥6.0% and <6.5% (≥42 and <48 mmol/mol). DM was defined as an FBG level of ≥7.0 mmol/l or an HbA1c level of ≥6.5% (≥48 mmol/mol). The prevalence of prediabetes was 4.3% (95% CI 3.4-5.3) based on FBG criteria [(males 6.4%; (95% CI 4.6-8.8), females 2.2% (95%

CI 1.7-3.0)]. The prevalence of prediabetes was 12.5% (95% CI 8.7-17.8) based on HbA1c criteria (males 11.8%; 95% CI 8.1-16.8, females 13.3%; 95% CI 8.9-19.5). Using both criteria (FBG or HbA1c), the prevalence of prediabetes was 15.2% (95% CI 11.4-19.9) on average with 15.8% for males (95% CI 11.8-20.7) and 14.6% for females (95% CI 10.4-20.1). The overall prevalence of DM was 5.6% when using the FBG criteria, 7.7% with HbA1c criteria and 7.7% with FBG or HbA1c.

The trend in the incidence of prediabetes in England between 2003 and 2011, for individuals aged 16 and above, was investigated by using data from the Health Survey for England. Individuals were classified as having prediabetes if the HbA1c level was between 5.7% and 6.4%[32]. According to the findings of this study, the prevalence of prediabetes increased from 11.6% in 2003 to 35.3% in 2011. Socio-economically deprived subjects were found to be at a substantial risk of developing prediabetes after controls for age, gender, race/ ethnicity, BMI and BP were all taken into account.

While in developed countries, this increase in prediabetes can be traced to an increase in obesity, an ageing population and an increased life expectancy for people with prediabetes[33], in developing countries it is due to rapid urbanization, increasingly sedentary lifestyles and unhealthy eating habits[34]. A high rate of DM and prediabetes has been reported in many developing countries. The prevalence of prediabetes and DM was examined in a population-based sample (n=57117) of adults aged 20 years or above in 15 Indian states using WHO criteria[35]. The overall prevalence of prediabetes was 10.3% (95% CI 10.0-10.6). This was higher in urban areas (14.7%; 95% CI 13.6-15.9) when compared to rural ones (6.0%; 95% CI 5.1-6.8). The overall prevalence of

DM was 7.3% (95% CI 7.0-7.5). It was higher lowly socio-economic groups, particularly in urban settings.

In China, the prevalence of prediabetes and DM was estimated via a cross-sectional design in a random nationally representative sample of adults (n=170287). DM and prediabetes were identified, based on FBG, HbA1c and a 2-hour OGTT that followed the ADA's classification system. The overall prevalence of prediabetes was 35.7%, while DM was 10.9% (95% CI 10.4-11.5), and already diagnosed DM stood at 4.0% (95% CI 3.6-4.3). The incidence of both DM and prediabetes varied by ethnicity. There was a lower incidence in Tibetan (31.3%) and Muslim Chinese (31.9%)[36].

The prevalence of prediabetes and DM was estimated in a demographic and health survey of 7,541 adults aged 35 or over in Bangladesh in 2011. Prediabetes was defined as a FBG level of 6.1 mmol/l to 6.9 mmol/l without DM medication. DM was defined as a FPG level ≥7.0 mmol/l with the self-reported use of DM medication. The prevalence of prediabetes and DM was estimated to be 22.5% and 10%, respectively. The overall age-adjusted prevalence of DM and prediabetes was 9.7% and 22.4%, respectively. Among urban inhabitants, the age-adjusted prevalence of DM was 15.2% as compared to 8.3% in the rural population. The risk of prediabetes in Bangladesh increased with age, and among wealthier and better-educated individuals, as well as in those with hypertension[37].

A community-based survey was conducted in Saudi Arabia in 2016 on 18 year-olds whether Saudi or not living in Jeddah (N=1420)[38]. DM and prediabetes were identified, based on FBG and HbA1c, using the WHO's classification system. Those with FBG of 100-125 mg/dl, and/ or HbA1c 5.7-6.4% were identified as having prediabetes. People with FBG of ≥126 mg/dl, and/or HbA1c ≥6.5% were categorized

as DM. Also, self-reporting of any previous diagnosis of DM and those taking drug treatments for DM were both classified as having DM. The prevalence of prediabetes and DM was 11.9% and 18.3%, respectively. The age and sex-standardized incidences of prediabetes was 9.0% (95% CI 7.5-10.5): 9.4% (95% CI 7.1-11.8) in men and 8.6% (95% CI 6.6-10.6) in women. For DM, it was 12.1% (95% CI 10.7-13.5): 12.9% (95% CI 10.7-13.5) in men and 11.4% (95% CI 9.5-13.3) in women. Also of note is that the prevalence of prediabetes and DM increased with age.

The prevalence of prediabetes in Oman in 2011 was estimated by using a cross-sectional design with an adult sample group aged 18 to 60 (n=1,600)[39]. Prediabetes was identified, based on FBG (100 mg/dl and 126 mg/dl) and OGTT (140 mg/dl and 200 mg/dl) levels. The overall prevalence of prediabetes in Omani adults was 35% and this increased with age. A higher prevalence of prediabetes was found among married, divorced, and widowed people, as compared to those who never married. A higher prevalence was also found among those with a lower level of education, the unemployed, smokers, and people with hypercholesterolemia and dyslipidemia[39].

In the UAE a multi-ethnic expatriate population accounts for 80% of the population of the country. The prevalence of prediabetes has previously been documented in native Emiratis in two studies. In 2007, a population-based sample was obtained from 452 householdsin al Ain. There were 2,455 adult (>18) Emirati citizens in this study. Their prediabetic status was based on a fasting venous blood glucose concentration of 5.6-6.9 mmol/l or a 2 hour post-OGTT venous blood glucose level of 7.8-11.0 mmol/l. DM was defined according to WHO criteria. The prevalence of prediabetes and DM was 20.2%, and 10.5% respectively. Age-standardized rates for prediabetes and DM among 30-64 year olds were 24.2% and 29.0%, respectively[40].

The Weqaya study conducted in 2010 obtained data from 50,138 Emirati adults aged 18 or above in 25 primary care screening centers in Abu Dhabi. Participants with HbA1c of 5.7%-6.4% were categorized as having prediabetes. Participants with a history of adult-onset DM and those on DM medication, an HbA1c of 6.5% or higher, or a random glucose level of 11.1 mmole/L were considered to have DM. The prevalence of prediabetes and DM was 27% and 18%, respectively[41]. Correlates for prediabetes were not evaluated in either of these studies.

Shah and his team reported on prediabetes and DM in a random sample (n=599) of female expatriates (non-UAE nationals) which included South Asian, Arab and Filipino subjects, aged 18 years and above living in Al-Ain (UAE) in 2012-13. The ADA guidelines on HbA1c were used to diagnose prediabetes (an HbA1c level of 5.7-6.4%) and DM (an HbA1c level ≥6.5%). In this cross-sectional study, the prevalence of prediabetes and DM was estimated at 18.6% (95% CI 13.9-24.4) and 10.7% (95% CI 7.2-15.6), respectively. The prevalence of prediabetes was 8.5% in Filipinos, 16.7% in Arabs and 30.3% in South Asians. The prevalence of DM was 1.7% in Filipinos, 12.2% in Arabs and 16.7% in South Asians. The prevalence of DM and prediabetes increased with the length of time spent in the UAE even after controlling for age.

Prediabetes is a significant economic burden. Identifying people with prediabetes is worthwhile from a clinical, financial and public health point of view[1]. In the last 5 years, the cost of prediabetes has increased by 74% to $44 billion. The increase is worrying as it means new cases of DM are not just an existing economic burden, but will also pose a potentially greater future burden unless prevention efforts are successfully implemented[42]. In the UAE, the annual medical cost of DM reached

$60 million (AED 220 million). The DM prevention program has shown that making lifestyle changes, including losing weight, increasing PA and changing one's diet can significantly decrease the risk of developing prediabetes and DM[43].

1.1.5 Correlates of Prediabetes

As the onset of DM can be prevented or delayed, identifying reversible correlates is essential in attempting to control the recent epidemic of DM[44]. It is possible that correlates for prediabetes could mirror those for DM[45].

According to guidelines from the European Society for Cardiology and the European Association for the Study of DM, prediabetes is associated with numerous conditions, including obesity, central obesity, ageing, physical inactivity, low consumption of fruit and vegetable, hypertension and a family history of DM. Furthermore, the American College of Endocrinology and the American Association of Clinical Endocrinology, have identified correlates for DM and prediabetes. They are as follows: a family history of the condition, being overweight or obese, an unhealthy lifestyle and hypertension[46]. Other correlates can include race/ ethnicity[47], abuse of alcohol, poor sleep patterns and obstructive sleep apnea, smoking, poor eating habits and a sedentary lifestyle[48,49].

a) Age

Age is a correlate for many diseases. According to the European Society for Cardiology and the European Association for the Study of Diabetes, age can be correlated for both prediabetes and DM. Furthermore, this causal connection has been confirmed by a study using secondary data from the Basic Health Research Survey conducted by the Ministry of Health in the Republic of Indonesia. This was a cross-

sectional study of 24,417 adults (aged 18 and above) from 33 provinces across Indonesia[46].

b) Family History

Having a family history of DM in a first degree relative, doubles the risk of developing DM and prediabetes, respectively, in the offspring. This correlation is evident even in the absence of obesity. Several studies have examined the association between a family history of DM and prediabetes. In Germany, 5,400 people with normal blood sugar levels and more than 2,600 with prediabetes were examined and it was found, after adjusting for sex, age and BMI, that people with a family history of DM were 26% more likely to develop prediabetes[50]. An earlier study in Sweden also established a 50% increased risk of prediabetes in people with a family history of DM[51].

c) Obstructive Sleep Apnea

Apnea attacks can occur anywhere from a few times to hundreds of times in one night[44]. Observational studies have identified sleep apnea as a correlate for prediabetes and DM[52,53]. In the UK, a study confirmed that sleep apnea was a correlate for DM, and effects the metabolism of glucose. This study involved 1,682 adults with DM who answered a questionnaire and it also utilized overnight oximetry[53]. This relationship can be explained by the sympathetic nervous system, the hypothalamic-pituitary-adrenal stress axis, and pro-inflammatory pathways becoming activated by chronic intermittent hypoxia and/ or sleep. Therefore, screening for sleep apnea should be standard practice for every patient with DM[54].

d) Obesity

Obesity is a reversible correlate for prediabetes and DM[55]. Men and women with abdominal obesity both displayed the strongest association to developing prediabetes. This relationship was stronger in men when compared to women[56]. Adipose tissue produces free fatty acids, adipocytokines, hormones, and other substances involved in insulin resistance[57]. Waist circumference (WC) is another proven correlate for prediabetes and DM[58]. These mechanisms are not clear but it might be because of the release of fatty acids from excess adipose tissue, inducing resistance to insulin in the muscle which, in turn, leads to a rise in plasma glucose levels[59]. Studies from around the world have confirmed that obesity is one of the main correlates for prediabetes and DM[27,60]. A cross-sectional study of 3,494 adults (≥20 years of age) obtained from a Canadian Health Measures Survey, showed that a high BMI and WC were associated with a higher prevalence of prediabetes and DM[31]. There was a similar finding in data collected from the 2011-2012 in the National Health and Nutrition Examination Survey in the USA[30].

e) Physical Inactivity

PA (including aerobic, resistance, flexibility and balance exercises) is critical for an individual's overall well-being and plays a key role in controlling blood glucose levels and BMI[61]. Adopting and maintaining regular PA (at least 150 minutes a week) improves our sensitivity to insulin and protects against prediabetes and DM[62]. According to the Pre-diabetes Consensus issued by the American College of Endocrinology and the American Association of Clinical Endocrinology, an unhealthy lifestyle and physical inactivity are correlates for prediabetes and DM[63].

1.1.6 Complications of Prediabetes

People with prediabetes have a higher risk of heart disease[3], nephropathy, retinopathy, neuropathies[32], strokes[26], DM and also higher mortality rates[16]. The reasons prediabetic people develop these complications are not entirely clear. However, it may be due to many causes such as the effect of higher blood glucose, the presence of other abnormal metabolites, such as free fatty acids, or the occurrance of correlates, that include dyslipidemia, hypertension and insulin resistance[65]. Furthermore, studies have shown that glucose levels lower than those that currently meet the definition of prediabetes might also be related to similar complications with prediabetes, mostly in high-risk individuals[64].

a) Neuropathies

Diabetic neuropathies are a heterogeneous group of disorders that have a variety of clinical signs. Nerve damage, or diabetic neuropathy, results from persistently high blood glucose levels. Although, it may take decades to develop, it is considered as one of the most incapacitating complications of DM because of the pain it causes and the lack of treatments available. The pain is due to the small fibers, which cause an unpleasant sensation of burning and tingling. The large fibers can also become involved, leading to numbness and the loss of protective sensations. This is correlated to diabetic foot ulceration. Although pain or numbness in the legs or feet might be the most common way of identifying neuropathy, it can also produce other symptoms, such as increased male erectile dysfunction, a higher frequency of idiopathic polyneuropathy, painful sensory neuropathy and the dysfunction of cardiac autonomic activity. This is manifested in reduced heart rate variability and parasympathetic modulation of the heart[66].

There are four types of diabetic neuropathy: peripheral neuropathy, proximal neuropathy, autonomic neuropathy and focal neuropathy. This study has demonstrated that subclinical small unmyelinated nerve fiber neuropathy[67] and autonomic neuropathy are commonly present in prediabetic patients with IGT. It is usually milder than the neuropathy suffered by people with DM[68].

b) Nephropathy and Kidney Disease

Diabetic nephropathy accounts for a significant amount of morbidity and mortality and is the principal cause of chronic kidney disease in Western countries including the United States[69]. It can be characterized by structural and functional changes in the kidney and is often diagnosed by persistent albuminuria (>300 mg/d or >200 μg/min). This must be detected on at least two occasions that are three to six months apart. Additionally, there is a progressive deterioration in rate of glomerular filtration and higher arterial BP[70].

Despite the fact that not everyone with DM develops diabetes neuropathy, it is a well-known condition amongst such people[71]. The cause of this is unclear, but cardiovascular disease (CVD) may explain much of the relationship between prediabetes and the development of chronic kidney disease[72]. Individuals with prediabetes need earlier detection and treatment to prevent the development, progression and complications of chronic kidney disease. This includes intensive glycemic control where the aim is to reach something close to normoglycemia and keep BP (BP) below 140/90 mmHg[66].

c) Retinopathy

Diabetic retinopathy is the most common reason for loss of vision in adults aged 20-74 years in the USA. The duration of DM and the level of glycemic control is the strongest correlate for the progression of diabetic retinopathy. High blood sugar damages micro blood vessels in the retina, leading to increased vascular permeability, hemorrhage and distortion of vision. In its most advanced stage, this can result in the formation of abnormal blood vessels on the surface of the retina and the posterior surface of the vitreous (proliferative diabetic retinopathy), causing scarring and cell loss in the retina. Macular edema can develop at every stage of retinopathy and is characterized by retinal thickening caused by leaky blood vessels[73].

The current study shows that retinopathy, a characteristic of DM, is present in people with prediabetes. In the DM prevention study, 7.9% of prediabetes patients had retinopathy[74]. Another study reported that IGT causes a fourfold increase in the incidence of retinopathy, when compared to age-matched control subjects[65]. Screening for diabetic retinopathy can prevent blindness by allowing for intervention and treatment to take place. Strict blood glucose and blood pressure control and timely laser photocoagulation therapy can prevent stop or, at least, delay the progression of diabetic retinopathy and thus prevent a loss of vision.

d) Cardiovascular Disease

Atherosclerotic CVD is defined as having a history of one of the following: a stroke, transient ischemic attack, peripheral arterial disease, stable/ unstable angina, acute coronary syndrome, myocardial infarction or arterial revascularization. It is the leading cause of mortality and morbidity worldwide. Large epidemiological studies

have shown that there is an association between an individual with IFG and IGT and an increased incidence of CVD and mortality[75]. Twigg et al. found that there was a two to threefold increased risk of CVD in adults with prediabetes, independent of its eventual progression to DM[45]. Therefore, early intervention at the prediabetes stage can prevent diabetic macrovascular complications[76].

Typical diabetic microvascular complications[77] also occur in nearly one tenth of prediabetic patients and are improved once restoration of the normoglycemia has been achieved[4]. This relationship may be confounded by other common correlates that are present between CVD and prediabetes[66]. This study indicates that IGT and HbA1c are associated with metabolic syndrome and correlate strongly with CVD as compared to IFG[78]. However, there is still an absence of longitudinal follow-up studies that compare HbA1c to OGTT in terms of the prediction of CVD.

1.1.7 Screening and Control of Prediabetes

In the last decade, the prevalence of DM has increased enormously worldwide. The IDF has put forward the idea of early diagnosis of prediabetes via screening and intervention as a fundamental strategy required for the accurate identification of people with prediabetes. Therefore, a robust and convenient screening test is essential to reduce, prevent and control the overall societal costs of DM and to stop prediabetes from progressing to DM. Screening for blood glucose has been used to identify individuals at high risk of developing DM or asymptomatic DM. Once prediabetes has been diagnosed, an aggressive treatment plan must be implemented in order to prevent, or slow down, the progression to DM.

Several recent randomized trials with adult subjects have confirmed that DM can be prevented, or delayed, through lifestyle intervention programs that promote improvements in diet, increased PA and weight loss. In the Finish Diabetes Prevention Study[79], 522 adults with IGT were randomized and received either a brief diet, a brief diet or exercise counseling (control group), or intensive individualized instruction on weight reduction through dietary control and PA (intervention group). After an average follow-up time of 3.2 years, there was a 58% relative reduction in the incidence of DM in the intervention group when compared to the control group. Similarly, in a Diabetes Prevention Program in the US[80], 3,234 subjects were randomized, according to their lifestyle, medication (metformin) or received a placebo. Compared with the placebo group, there was a 58% reduction in the progression to DM in the lifestyle intervention group, and a 31% relative reduction in the progression of DM in the metformin group over a period of 2.8 years on average.

Identifying patients with prediabetes, and then intervening before it has progressed to DM, has significant benefits for both individuals and healthcare systems. On an individual level, it leads to an improvement in health thanks to early referral to specialists and by beginning treatment before the onset of complications. Such complications include micro and macro-vascular diseases, as well as other co-morbidities. Furthermore, studies have shown that prediabetic adults, who are aware of their condition are more likely to get involved in DM risk-reducing activities compared to people who are unaware[81]. In addition, the early detection of prediabetes is cost-effective, as it leads to a reduction in the demands on the healthcare system and gives DM patients a better chance of obtaining higher quality healthcare services[82].

This study has shown that prediabetic adults, who are aware of their condition are more likely to get involved in activities to reduce their risk of developing DM than those who are unaware of the issue[81]. Furthermore, there are no clear and especially specific symptoms for prediabetes. Some people with prediabetes might have symptoms such as fatigue and an increased appetite, or other complications of DM. Therefore, a patient could have prediabetes without knowing it, making screening vital[80]. As such, the ADA has recommended that screening for prediabetes should start at age 45 and above for those who have no previous DM correlate[1]. However, it recommends that overweight and obese people with one or more DM correlate should be screened regardless of age, even if they are asymptomatic. Normally, testing these groups requires repeated measures at a minimum of three-year intervals[1]. According to the WHO, the downturn in the implementation of screening programs for prediabetes and DM is down to cost involved and the increasing load on the healthcare system. There is a need to not only screen for such cases, but also for treating the increasing number of individuals diagnosed with prediabetes and DM[28].

1.2 Overview of Obesity and its Role in Diabetes and Prediabetes

DM is fast becoming a major cause of illness and premature death worldwide and its increase parallels a rise in obesity. With greater economic prosperity in the UAE, the population has settled into a sedentary, well-fed lifestyle. Reports from the UAE show that it has one of the highest rates of obesity in the world and this might result in more DM and prediabetic cases.

Obesity is a major public health problem. It is principally a social and environmental disease. The WHO considers “globesity” to be a growing epidemic, not only in developed countries, but also in developing ones. This often neglected yet

visible problem leads to a variety of health consequences, ranging from the increased risk of premature death through a reduction in quality of life, to chronic diseases, like cancer, CVD and DM[83].

1.2.1 Definition and Classifications of Obesity

a) BMI Classification of Obesity

Obesity is defined as the accumulation of abnormal or excessive fat that puts health at risk. There are several ways to the percentage of body fat. Some are used in clinical settings and others in research environments. In research, methods include the use of magnetic resonance imaging, multi-frequency bioelectrical impedance analysis and underwater weighing (densitometry). In a clinical environment, the techniques used are less accurate for the percentage of body fat, but are appropriate to identify correlates for different diseases. These methods include the use of the body mass index (BMI), WC and skin-fold thickness.

Adult obesity can be classified by using BMI. It uses two body dimensions to describe people as being overweight and/ or obese: a person's weight in kilograms (kg) divided by the square of his or her height in meters (m^2). The WHO has classified people with a BMI (kg/m^2) of 18.50-24.99 to be within the normal range, those with a BMI (kg/m^2) of 25.00−29.99 to be overweight and those with a BMI (kg/m^2) that is greater than, or equal to, 30 are considered as obese. Obesity can be sub-classified into class I (BMI 30.00-34.99), class II (BMI 35.00-39.99) and class III (BMI ≥40)[84].

BMI is the most common screening test for obesity. It is reliable, easy to measure and its values are age-independent, and it is similar for both genders[85]. BMI correlates well with the percentage of body fat and vital health outcomes, like coronary

heart disease and DM. As it increases, mortality rates increase as well. This makes it a good tool for screening, monitoring the effect of treatment and determining institutional policies for individuals. BMI is limited, however, because it is unsuitable for children due to their growing and changing body shape. It fails to distinguish between fat and fat-free mass, like muscle and bone, which can lead to obesity being exaggerated in large muscular individuals.

WHO classifications of being overweight and obese can be used internationally. However, Mascie-Taylor and Goto have a different opinion[86]. They have taken into consideration the differences between ethnicities, and concluded that a universal BMI cut-off point does not seem appropriate for all ethnic groups. Therefore, there is a growing discussion on whether there is a need to develop different BMI cut-off points for different ethnic groups, as the current WHO cut-off point does not provide an adequate basis for taking action when it is used with the Asian population, for example. There are several reasons for this. Firstly, Asian people have a higher percentage of body fat than Caucasian people of the same sex, age and BMI. Secondly, the proportion of Asian people with correlates for DM and CVD is large, even below the WHO cut-off point for being overweight (25 kg/m^2). Also, BMI grading in relation to the risk of disease may vary for different populations[84]. For example, an obese lady (class one) will have a greater risk of disease if her WC is higher than 88 cm, compared with a similar lady with a normal WC (<88 cm).

In 2002, WHO experts suggested that the international cut-point be used in the Asian population for reporting purposes only. However, for public action the cut-off points (23.0, 27.5, 32.5, and 37.5 kg/m^2) must be lower level than for the European population in general. Studies from Singapore and Hong Kong reported that a higher

percentage of body fat at a lower BMI reflected an increase in the correlates for chronic diseases and death in the Asian population. Likewise, Chinese studies have indicated that a prevalence of hypertension, DM and dyslipidemia increases with the increase in the BMI, even at indices that are below the current cut-off point for being overweight. For many Asian populations, the cut-off point of 18.5-23 kg/m^2 represents an acceptable risk, 23.0-27.5 kg/m^2 represents an increased risk and 27.5 kg/m^2 and higher represents high risk[86].

Although BMI has usually been the indicator used to measure body size and composition, WHO reports have confirmed that using other methods for measuring abdominal adiposity, such as WC, waist-hip ratio and waist-height ratio (WHR), are superior to BMI for predicting the risk of CVD. BMI and WC combined predict greater variants in health risk than just using BMI alone[83]. The National Heart Lung and Blood Institute confirmed that it was the same for WC[87].

b) Central or Abdominal Obesity

As above, BMI has usually been used to measure body size and composition. However, WHO reports suggest that other methods of measuring abdominal adiposity, such as WC, WHR and waist-height ratio, are superior to BMI in predicting NCD, especially DM. The National Heart Lung and Blood Institute has indicated that adding BMI and WC predicts a greater range of health risks than using BMI alone[83,87]. A twelve-year follow-up study of middle-aged men showed that abdominal obesity was related to an increased risk of many diseases, including CVD and premature death. In women, BMI was associated with an increased risk of these diseases as well: however, central obesity was a stronger correlate than BMI[83].

WC is an accurate and simple measure of abdominal obesity, compared to WHR and BMI. It is measured by using a stretch-resistant tape that provides a constant 100g tension at the mid-point between the top of the iliac crest and the least palpable rib. Hip circumference should be measured around the widest portion of the buttocks, with the tape parallel to the floor. Both measurements must be taken while the subject is in a relaxed standing position, with their feet close together and arms at the side of the body, and at end of normal expiration. The normal range for WC is less than 80 cm for women and 94 cm for men. The higher the WC, the higher the risk of metabolic complications (Table 1.3)[83]. The WHR is measured by dividing the WC by the hip circumference.

Table 1.3: WHO cut-off points and the risk of metabolic complications

Indicator	**Cut-off points**	**Risk of metabolic complications**
WC	>94 cm (men); >80 cm (women)	Increased
WC	>102cm (men); >88 cm (women)	Substantially increased
WHR	≥0.90cm (men); ≥0.85 cm (women)	Substantially increased

This study has shown that BMI and WC have a strong positive correlation (P<0.0001) with the percentage of body fat in males and females, and are good indicators of metabolic syndrome, CVD and DM, compared to WHR[88].

The cut-off points for WC and WHR, which are proposed for general use, are based on Caucasian or European populations and so should not be applied uniformly to every population and ethnic group. Many studies of populations have recommended using cut-off points that are specific to different ethnic groups. The reasons for this are that Asian populations appear to have higher morbidity at lower cut-off points for WC than Caucasians. In addition, the prevalence of abdominal obesity among Asian males

was higher when using the WC cut-off points for Asian people, compared to the WC cut-off points for Caucasians. Below is a table summarizing the WC cut-off points for some ethnicities[89] (Table 1.4).

Table 1.4: Cut-off values of WC based on ethnicity and gender

Country/ethnic group	Sex	WC
Europid	Men	>94 cm
	Women	>80 cm
South Asian	Men	>90 cm
	Women	>80 cm
Chinese	Men	>90 cm
	Women	>80 cm
Japanese	Men	>90 cm
	Women	>80 cm
Ethnic South and Central Americans	Use South Asian recommendations until more specific data is available	
Sub-Saharan Africans	Use European data until more specific data is available	
Eastern Mediterranean and Middle East	Use European data until more specific data is available for (Arab) populations	

Source: Alberti, 2006[90]

1.2.2 Epidemiology of Obesity

Over the past 30 years, there has been a dramatic increase in the prevalence of obesity. In fact, obesity rates almost doubled from 1980-2008. In 2008, 10% of men and 14% of women worldwide were obese (BMI ≥30 kg/m^2), compared with 5% for men and 8% for women in 1980. An estimated 600 million adults were obese in 2014. In the same year, an estimated 41 million children under the age of five years were overweight or obese[91]. Obesity has reached epidemic levels worldwide[92] and the WHO considers it as being one of the most serious health challenges of the early 21st Century and a major public health concern in developed and devolving countries[93]. Eating unhealthy food, sedentary lifestyle and a lack of PA are major contributors to these

alarming rates that, in turn, can lead to an increase in body fat that has been linked to several diseases[94].

The prevalence of obesity has increased at different rates in all of the WHO regions. It is most prevalent in the WHO Regions of the Americas (26% obese) and least prevalent in the WHO Region of South-East Asia (3% obese). Furthermore, the prevalence increases with income level, up to upper middle-income levels. The difference in both sexes more than triples from 7% obesity in lower middle-income countries to 24% in upper middle-income countries. Women were more likely to be obese than men in all of the WHO regions. Female obesity was significantly higher than male in low and middle-income countries, but it was similar in high-income nations[94].

In the USA, obesity has increased across all age groups. During the past 20 years, there has been a dramatic rise in obesity rates in the United States[92], according to the Center for Disease Control and Prevention (CDC). From 2011-2014, the prevalence of obesity was 36.5% among USA adults, and it is projected that this figure will rise to 47% by 2030[92]. Furthermore, there has been an increase in the number of overweight men and women over the last few years. Between 2005 and 2015, the proportion of overweight or obese adults rose from 60.5% to 62.9% and the proportion of adults who are morbidly obese increased from 1.8% to 2.9%. In England, 27% of adults are obese and an additional 36% are overweight, making a total of 63% who are either overweight or obese[95]. The Organization for Economic Co-operation and Development (OECD) reported in its Obesity Update for 2017 that more than one in two adults is either overweight or obese in OECD countries[96]. Over the past decade, the rate of overweight adults and obesity has increased in Canada, France, Mexico and

Switzerland. In 2015, 19.5% of the adult population across the OECD countries were obese, and there is no clear indication of a reduction in any country[96]. OECD projections have also shown that obesity levels are expected to be high in Mexico and England, where 39% and 35% of the population, respectively, are projected to be obese by 2030[96]. On the contrary, it is predicted the rise will be slower in Italy and Korea, where obesity rates are expected to be 13% and 9% respectively in 2030[96].

Globally, there are more obese people than hungry people, even in developing countries. Low and middle-income countries are now facing a double burden. They are experiencing a rapid increase in people being overweight or obese, while continuing to combat infection, disease and malnutrition. In Bangladesh, there has been a dramatic increase in obesity. A secondary data analysis of the National Bangladesh Demographic and Health Survey showed that the prevalence of obesity stood at 4.6% among the adult population in 2011, compared to only 1.1% in 2008[97]. It also showed that the rate of obesity was higher among women, people with a higher level of education, the wealthy and those who lived in urban areas[98].

While the incidence of obesity has doubled in some countries in the past 25 years[99], it has tripled in Arab nations[100]. It has even become a problem in poorer Arab states and among low-income groups, creating both health and economic burdens on government services. A 2008-2009 national survey in Lebanon showed that the prevalence of obesity among adults aged 20 and over was 26.1%[101]. This figure increased to 52.7% in 2016[102].

The WHO has reported that the GCC countries have one of the highest rates of obesity worldwide. Kuwait, Bahrain, Saudi Arabia and the UAE are in the top ten most obese countries. In Saudi Arabia, obesity has increased on a national level. In 2008,

the WHO reported that the prevalence of obesity was 42%, 33.2% and 33% in the adult populations of Kuwait, Qatar and Saudi Arabia, respectively. In 2015, those figures had risen to 39% in Saudi Arabia, remained stable Qatar and reached 42% in Kuwait[103]. This places Kuwait in the top ten most obese countries globally. The increase in obesity in the region is due to the high consumption of fast food and sugar-dense beverages, as well as technological advances that have reduced activity levels. There has also been a reduction in the consumption of traditional, locally grown natural food, such as dates, vegetables, and wheat[103].

Over the past four decades, there has been a move from a traditional semi-nomadic, physically active lifestyle to a modern, urbanized, technology-driven lifestyle in the UAE, characterized by low domestic, occupational, leisure time physical activity (PA). This is combined with the over consumption of energy-dense convenience foods of poor nutritional content. Therefore, there has been a dramatic growth in the prevalence of obesity in both the native Emirati and expatriate adult population living in the UAE[104], which has resulted in an increased in obesity[105]. The UAE's Ministry of Health and Community Protection (MOH) considers obesity and DM to be the biggest health issue facing its people. In 2012, the prevalence of obesity among Emirati nationals from Abu Dhabi was 35% (38% women and 32% men)[41], compared to 32% (39.9% women and 30% men) in 2008[106]. In 2015, the prevalence of obesity in the UAE was estimated to be 34% among adults[107].

1.2.3 Correlates for Obesity

Obesity is a major problem worldwide and its causes are both complex and multifactorial. It results from a long-term imbalance of energy intake and expenditure that can lead to a positive energy status resulting in the accumulation of body fat[91].

The human brain regulates our feeding behavior while the hypothalamus controls long-term energy balance and body weight. Defects in hormone levels and the hypothalamus are thought to cause the pathogenesis of energy imbalance that results in obesity.

Genetic factors also play a role in developing obesity[108]. Some studies have reported that BMI is 25-40% genetic. However, the prevalence of obesity has increased in the last two decades, which indicates that the reason is not due to genetic factors. It is reasonable to say that this recent increase in both developing and developed countries is down to environmental factors. In addition, modern societies have adopted a Western diet and time-allocation patterns have changed[109], leading to a positive energy situation caused by over-nutrition, physical inactivity and a sedentary lifestyle[110].

1.2.3.1 Environmental Factors

Public health experts agree that obesity is best fought by restructuring the environment rather than concentrating on an individual's behavior[111]. Harvard School of Public Health has claimed that the "environment has become toxic to healthy living" and it is difficult for an individual to make a healthy choice that is vital for a healthy weight. The obesogenic environment has been defined as a sum of the effect that surrounds us, and it encourages obesity in individuals and the population. It includes schools/ universities, homes, workplaces, community spaces, and the media[112]. Features of this environment include easy accessibility to, and the affordability of, highly advertised foods and inactive lifestyles. Spence et al. reported that the proximity of the obesogenic environment, where people struggle against unhealthy energy-dense food consumption and a sedentary lifestyle, is a vital correlate for obesity. They added

that shaping the environment in such a way that it encourages healthy decisions is the key feature in the prevention of obesity[113]. Cities in the UAE are unfortunately not designed for walking, making automobiles the first choice. The high temperature of 45^0C in the Summer and the dusty conditions restrict people in the UAE and discourage and them from exercising, especially women[114].

1.2.3.2 Physical Activity (PA)

PA is defined as any body movement made by the skeletal muscles that involves energy expenditure. Lack of PA is the fourth leading cause of death worldwide, and it is a major correlate for several common chronic diseases. Globally, 31.1% adults are physically inactive. A third of adults do not meet the public health guidelines for suggested levels of PA[115].

Between 1977 and 1995, active transportation has dropped for all age groups. In the United States, it was estimated that only 21.1% adult and 35.9% children walked regularly[116]. The level of PA among adults is also low in Canada[117], the United Kingdom and other developed countries[118]. Al-Hazzaa et al. reported that 71% of young people in Saudi Arabia did not engage in PA for a sufficient duration or frequency[119].

A significant lack of PA among the UAE population has been documented in several research studies[120]. A cross-sectional study, conducted in 628 randomly-selected households in all seven emirates, revealed that only 41% of adult Emirati women have moderate or high levels of PA and 75% of Emirati girls and adolescents spend more time (>5 hours per weekday) sitting, compared to their male counterparts (50%)[121]. Age was a major determinant of the level of PA (negative association) in the

UAE. Henry et al. confirmed that PA in childhood and adolescence may affect activity patterns in adulthood in the UAE[122].

It is advised that adults take at least 150 minutes of moderate intensity PA or 75 minutes of vigorous PA every week[118]. Berger and colleagues examined the barriers to physical activity for 600 female students in a women's college in Fujairah. This study identified that important determinants for PA in the UAE were a lack of female role models among peers and families, information about the benefits of exercise, culture, climate, clothing, make-up, personal motivation, time and opportunity, as well as school and government policies[120]. A qualitative study conducted by Habiba et al., demonstrated that environmental barriers, like not having culturally accepted exercise facilities for women, hot weather and safety concerns – especially at night – played an important role in discouraging Emirati females from exercising[123].

1.2.3.3 Sedentary Lifestyle

A sedentary lifestyle is defined as the time that people spend sitting, resulting in lower metabolic expenditure[124]. It is one of the key determinants of the growing rates of being overweight and obese in Western populations[125]. Worldwide, the proportion of adults who spend 4 or more hours per day being sedentary (watching television, driving cars, sitting, sewing, playing board/ computer/ phone games) is 41.5%[126]. Owen et al. reported, in a cross-sectional study of 5,078 Australians, that sedentary behavior increases with age, and is more common among less educated and lower income people[127]. Similar findings were observed in the USA[128]. Most Canadian adults' working hours (68% men and 69% women) are sedentary[129]. They spend an average of 10 waking hours per day being sedentary (not including sleep).

The time spent in sedentary activity, including watching TV, has increased dramatically in almost all the major Arab countries[119]. For instance, in the UAE, the median number of hours that 58 adolescent females aged 11-16 years spent watching television was 2.5 per day, and the number of hours increased at the weekend[122]. Musaiger et al. found that watching television occupied significant amounts of children's and young adults' leisure time in the UAE, and the practice of having meals in front of the television was also very common for families in the UAE[130].

1.2.3.4 Nutritional Factors

Dietary factors have been comprehensively studied for their likely contributions to growing obesity rates. These factors are the size of food portions, daily consumption of fruit and vegetables, the role of breakfast, consumption of fast food and sugary beverages.

Studies suggest that two vital lifestyle choice factors contribute to the increasing rate of being overweight and obese in the UAE. These are dietary (frequent snacking, the replacement of traditional food with fast food, replacing water with a soft drink, low fruit and vegetable consumption and wealth) and increased physical inactivity[121].

a) Food Portion Size

The size of food portions is the amount of a single food item served in a single meal or snack time. For example, the amount of food put on a plate or the quantity offered in readymade food packages. The WHO believe that large food portions play an important role in the global obesity epidemic[84]. The propensity towards a rise in portion sizes began in the late 1970s and has increased ever since. In the USA, portion sizes have risen sharply over the last 30 years, especially those that have a high energy

density. This has led to the overconsumption of food and has fueled the growing obesity epidemic. The current portion sizes for hamburgers, French fries and soda are 2-5 times larger than they used to be[131]. A study shows that, except for sliced white bread, all commonly available food portions exceed the USA Department of Agriculture and Food and Drug Administration's standard portions, sometimes to a very large extent. In the UAE, there has been a change from traditional food to a more Westernized diet leading to the consumption of high-dense energy foods and bigger portions. Musaiger et al. have attributed the epidemic of childhood obesity in Dubai mainly to these reasons[130].

Ledikwe et al. have attributed the rise in the obesity rate in the last three decades to the increase in portion sizes for many foods and the frequency of eating outside the home. They emphasize the importance of eating a healthy balance of different types of food in order to control obesity[132]. A study by Rolls et al. examined how adults reacted to different portion sizes. They found that the bigger the portion, the more the participants ate. Those offered a larger portion consumed 30% more energy compared to others who were offered a smaller portion of food[132].

b) Daily Consumption of Fruit and Vegetables

It has been well established that fruit and vegetables are important components of a healthy diet and can help to prevent a wide range of diseases. Fruit intake in most Western countries is well below the daily recommended amount (five servings a day)[133]. The WHO recently recommended a minimum intake of 400g or five portions of fruit and vegetables per day to prevent obesity and other chronic diseases[134]. Having daily fruit and vegetables leads to good weight management through the replacement of energy-dense food with healthier choices that ensure satiety due to eating fiber. This

leads to the consumption of fewer calories and modulation of the dietary glycemic load which affects postprandial hormonal shifts[135].

Traditional UAE food, which is high in fiber and low in fat, has been largely replaced by a Westernized diet with a higher content of fats, sugar, sodium and cholesterol. It is also low in fiber-rich foods, such as vegetables, fruit and whole grains[136]. The Bedouin Emirati, who live in rural areas and have maintained their traditional food culture, have lower obesity rates than those in urbanized areas[137]. Daily fruit and vegetable consumption is low in the UAE. This has been reported by Musaiger and Abuirmeileh, who confirmed low fruit and vegetable consumption in a cross-sectional study in all seven Emirates by random sampling of 1,122 men and 1,090 women[138]. Zaal et al. reported that fruit and vegetables are less accessible in the UAE compared to high-dense energy food, and the consumption of canned fruit is higher than fresh fruit and vegetables[130].

c) Role of breakfast

There is a relatively strong public belief that having breakfast regularly plays a role in human health. The frequency of people skipping breakfast has increased over the past few years, during which time the obesity epidemic has increased worldwide. Thus, there is a strong scientific belief that a causal relationship between obesity and breakfast exists (inversely correlated).

Several clinical studies have demonstrated that regular food consumption reduces the risk of obesity. A systemic review of 16 European studies has suggested that skipping breakfast increases the correlate for people becoming overweight and obese because they tend to overeat at lunch or dinner[130]. This positive association is observed internationally, regardless of the culture in a diversity of countries[139]. The

odds of becoming obese as a result of skipping breakfast is 4.5 times higher, compared to people who regularly eat breakfast[140].

Research studies have shown that skipping breakfast is highly prevalent in many Arab countries. In the UAE, Musaiger reported that 28% of Emirati boys, aged 6-7 years, skip breakfast compared to 37% of girls of same age[100]. Furthermore, Kerkadi conducted a study on 400 female students from UAE University. Students who had breakfast regularly (72.2%) were less likely to be obese than those who did not and were consequently either overweight or obese.[141].

d) Consumption of Fast Food

Consumption of fast food has been closely associated with obesity in recent years. Fast food consumption increased fivefold worldwide from 1977 to 1995 in 2-18 year olds and nearly one third of youths now eat fast food every day. Studies have shown that weekly consumption of fast food by young adults is associated with an increase in BMI[142]. Isganaitis et al. considered fast food to be the primary cause of the current obesity epidemic[143].

There is a close association between the proximity of fast restaurants to residential areas, exposure to fast food advertisements and an increase in the risk of obesity. Fuzhong et al. studied 1,221 residents from 120 neighborhoods. They measured their BMI, level of PA, frequency of visits to local fast food restaurants and fried food consumption. They reported that an increase in neighborhood fast food outlets was associated with an unhealthy lifestyle and an increased risk of obesity among adults[144]. Furthermore, a positive correlation between exposing children to fast food advertising and BMI has been established in several studies. It has been shown

that banning such advertisements reduces the number of overweight children and adolescents by 10% and 12%, respectively.

The UAE's economic boom and concomitant Westernization has resulted in a greater dependence on fast food[130]. The easy accessibility of this food is another concern. Studies have revealed that 76% of participants had consumed fast food at least once a day during the seven days before the data was gathered[145]. This was much higher than the figure reported by Kerkadi, who found that 34.9% of female students at the same university consumed fast food at least once a day[141].

e) Consumption of Sugar Sweetened Drinks

Many studies have been carried out into the relationship between consuming sugary drinks and weight gain. These drinks have repeatedly been found to correlate for obesity. Over the last three decades, the consumption of sugar sweetened drinks, including soft drinks such as iced tea, fruit drinks and energy and vitamin water drinks, has increased noticeably worldwide[146]. Between 1977 and 1996, there was an upsurge in the percentage of people consuming these beverages (from 61.4% to 76%), the frequency of consumption (from 1.96 to 2.39 servings per day), the portion size (from 13.6 to 21 oz/d) and calorie intake (from 70 kcal to 189 kcal per day)[143]. US studies have shown that approximately 50% of Americans aged 4 and above regularly drink soft drinks on a daily basis. They have replaced dairy drinks and become a leading source of carbohydrates, especially in children and teenagers[147]. In the UAE, Zaal et al. found that high consumption of energy-dense foods, such as carbonated canned drinks, during the day and at night was a major reason for gaining weight[130].

1.2.4 Consequences of Obesity

Obesity is associated with a large number of health, social and emotional problems. The social and emotional effects of obesity include suffering discrimination, receiving lower wages, poor quality of life and depression. The health problems start when an individual is slightly overweight and they increase as the weight increases, causing serious mortality issues (CVD, DM, hypertension, kidney stones, infertility, musculoskeletal illnesses), and some types of cancer (endometrial, breast and colon) as well as morbidity[91]. The Nurse Health Study showed the risk of death rose in women with a BMI of more than 29 kg/m^2 and mortality was lowest among those women whose weight had remained unchanged since early adulthood. The American Cancer Society's Cancer Prevention Study 1 and 2 came to the same conclusion.

1.2.5 Association of Obesity with Prediabetes and DM

Obesity is a major correlate for DM and prediabetes[150]. Furthermore, DM and prediabetes are closely associated with a high BMI, and visceral fat is an independent correlate for insulin resistance. Numerous other measurements of obesity, including WC, WHR and waist-to-stature ratio, are associated with DM and prediabetes[27,151].

The relationship between DM and obesity was explored in a National Health and Nutrition Examination Survey, where 21,205 adults were examined for DM. Among the people with DM (13.6%), 80.3% were overweight and 49.1% were obese, and the prevalence of DM rose the more severely obese they were. 'Diabesity' is the term used to describe the strong epidemiological and pathogenic relationship between DM and obesity. Studies have also confirmed the significance of weight loss in improving control of DM, which has, in some cases, led to people reverting back to

normoglycemic status. “Look AHEAD” was a large multicenter trial where overweight/ obese adults with DM randomly selected to participate in a rigorous lifestyle intervention (with a reduction in calorie intake and increased PA levels) or receive DM support and education only. After a follow-up one year later, it was noticed that weight reduction in the intervention group (8.6% weight loss) was significantly associated with an improvement in DM control in obese and overweight adults with DM, when compared to patients in the control group (0.7% weight loss)[149]. In spite of the close relationship between obesity and DM, the real mechanisms are not straightforward, given that not all obese and overweight people develop prediabetes or DM, and that there are people of normal weight who develop prediabetes and DM regardless.

Studies have shown that obese people are five to six times more at risk of developing prediabetes, compared to normal-weight people[57]. In addition, people who lose 5-10% of their weight through a healthy diet and exercise regime can significantly reduce their risk of developing prediabetes[4,7]. Furthermore, the USA Prevention Program’s multicenter clinical research study involved training overweight patients with prediabetes to lose weight through dieting and PA, medication or a placebo. After both three and ten year follow-ups, it was evident that losing weight (through dietary changes and increased PA) had an effect on reducing the incidence of DM when compared to the placebo or the use of medication in prediabetic patients. Moreover, the observed reduction in the incidence of DM in this study was 58% in people who lost weight through dietary changes and 34% in people who lost weight through increasing their level of PA[80].

1.3 Summary

The prevalence of prediabetes in every age group is rising exponentially around the world causing massive health problems and a significant economic burden. This increase is due to population growth, aging, urbanization, and a growing number of people who are physically inactivate. Obesity is one of the main correlates for developing prediabetes. The ADA and WHO use FBG, OGTT and HbA1c for the diagnosis of prediabetes, which is a major correlating factor for many diseases. However, people can revert to normoglycemic status through modification of their lifestyle.

This dissertation is based on secondary data. Both sets of data were collected during an intervention with prediabetic adults in Al Ain, Abu Dhabi and Dubai, in the UAE as part of a National Research Foundation (NRF) funded grant for the "prevention of diabetes through population-based strategies". The data from Al Ain was secondary data based on NCD correlates and was obtained from a random sample of school children and their parents. In this dissertation we used parental data to achieve the primary objective of the esearch i.e. to ascertain the prevalence of prediabetes and its identify its correlates (Described in Chapter 2). The Dubai data was collected as part of case study where 700 adults were identified with prediabetes in five primary health care centers in Dubai in 2015 as part of the Dubai Health Authority diabetes screening and prevention program. Participants were re-examined in 2017. The data here was used for the secondary objective, that is to determine the correlates when prediabetes develops into DM. The total number of participants was 605 in Al Ain and 487 in Dubai (Described in Chapter 3).

In the UAE, there is no recent data on the prevalence of prediabetes, and little data on the correlates when prediabetes develops into DM. The results of this study encourage two-way communication between researchers and decision makers to help shape regulations and laws to fight obesity and prediabetes. It will also show evidence that can inform policy makers on how to control diabetes in the UAE.

Chapter 2: Prevalence of Prediabetes and its Correlates - Al Ain

2.1 Aims and Objectives

2.1.1 Aims

Prediabetes is a high-risk state for the development of DM. Furthermore, a substantial number of people with DM remain undiagnosed and untreated. Our study aims is to document the burden of prediabetes and its correlates in the UAE. Also, we seek to improve the current understanding of the relationship between prediabetes and its correlates in married adults in Al Ain, the UAE.

2.1.2 Specific Objectives

- Objective 1:
    - To estimate the prevalence of prediabetes in married adults in Al Ain, the UAE
- Objective 2:
    - Evaluate the relationship between prediabetes and its correlates in married UAE nationals/ Arab adults in Al Ain, the UAE

2.2 Methods

2.2.1 Study Design

We used a cross-sectional design to achieve our study objectives.

2.2.2 Study Site

This study was conducted at the Al Muwaiji Healthcare Center in Al Ain, Abu Dhabi, in the UAE. Al Ain is the 4th largest city in the country. It is located 160

kilometers east of the capital Abu Dhabi. The city covers an area of 13,100 Km^2 and has a population of 650,000 (according to the UAE census 2013). The United Arab Emirates University is located in Ali Ain and Abu Dhabi Health Authority provides health care through a number of primary healthcare centers. The participants were all invited to attend the Al Muwaiji Healthcare Center to be measured and have blood tests. This primary healthcare center is affiliated with Ambulatory Healthcare Services in Al Ain, Abu Dhabi.

2.2.3 Study Population

The Al Ain based data used in this dissertation was secondary data about NCD risk factors. Details of the primary study are summarized in Figure 1. For our study purposes, every participant was either a married UAE national or an Arab national with children in school who lived in Al Ain. Out of 866 participants contacted, 605 agreed to participate and signed the informed consent form.

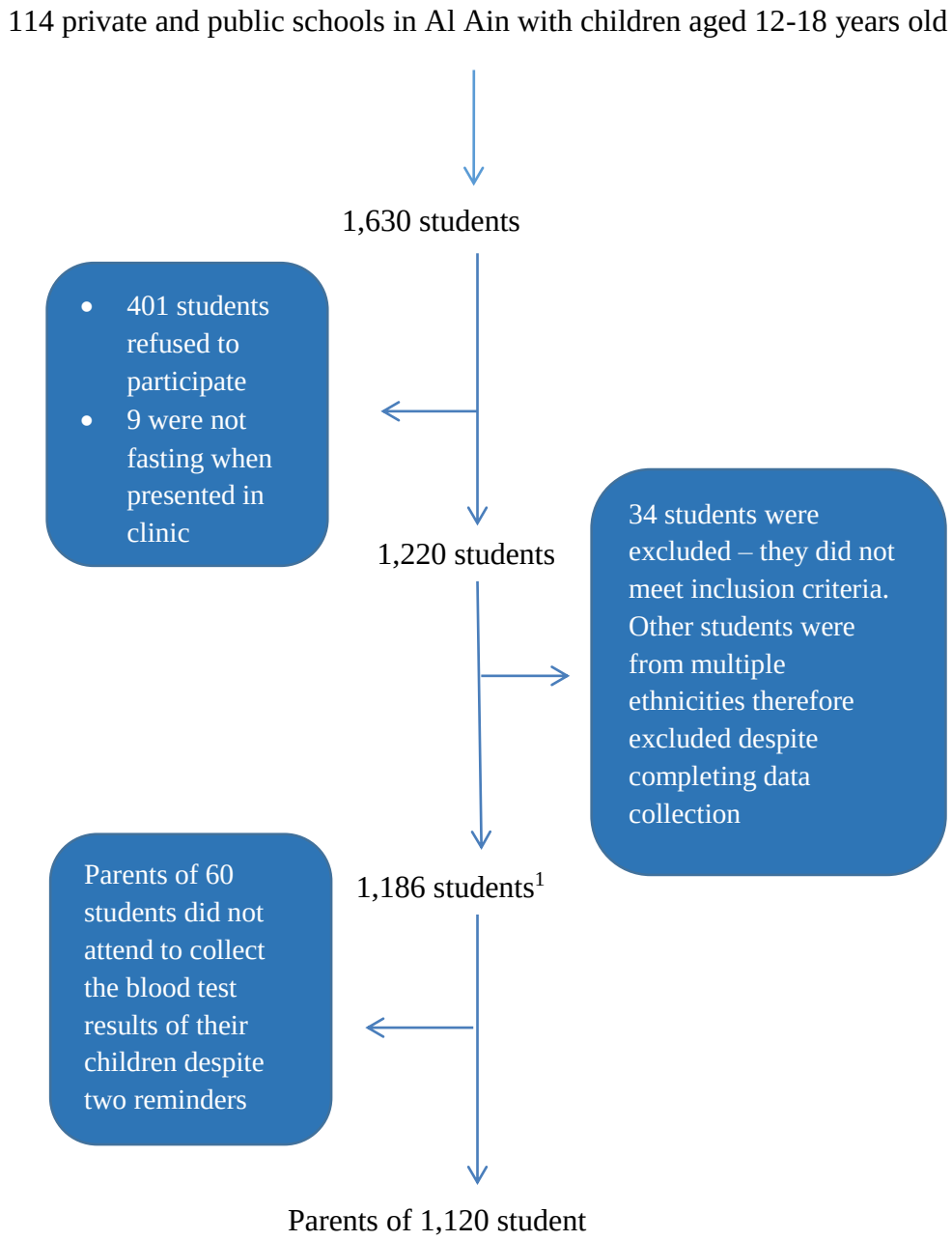

Figure 1: Summary of primary data collection in Al Ain, Abu Dhabi, the UAE

1. As part of a previously completed global health study "Developed developing countries partnership for NCDs prevention", a random sample of 1,186 adolescent, aged 12 to 18 years from 114 public and private schools in Al Ain completed a school-based NCDs risk factors study. Approval was obtained from Abu Dhabi Education Council. Parents of 1,186 students were contacted though telephone by a staff nurse in Al Muwaiji Healthcare Center in Al Ain to come and take a blood test (Fasting blood sugar& lipid) conducted by a pediatrician. Contact numbers were obtained from the medical file of each student. Nurses from Al Muwaiji Healthcare Center in Al completed the measurement of 1,186 students. The measurements were as followis: Self-administered Questionnaire, I PAQ, Beck & Rosenberg self-esteem scale II. Weight, height, waist, blood pressure III. Blood samples after fasting overnight.

2.2.4 Selection of the Study Participants

2.2.4.1 Inclusion Criteria

1. The participants were either a father or mother of the adolescents studied.

2. UAE nationals and Arabs.

3. Resident in Al Ain.

4. They were willing to participate and signed the informed consent form.

2.2.4.2 Exclusion Criteria

1. Participants who did not fulfill any of the inclusion criteria.
2. Those who did not sign the informed consent form.

2.2.5 Sample Size Calculation

The sample size was determined by using a single population proportion formula. It was reached by considering the 27% prediabetic prevalence discovered in the Weqaya study[41] of the prediabetic Emirati population. We had a 95% confidence level with 0.05 margin for error. This came to 302, and by adding 50% for the non-response rate, the total sample size was 605 participants.

2.2.6 Study Measurement

2.2.6.1 The Primary Variable

The primary variable was the prevalence of prediabetes and DM.

2.2.6.2 The Study Variable

Being overweight, obesity and central obesity.

2.2.6.3 Other Variables

Socio-demographic characteristics

- Age, tobacco use, educational level, smoking, history of chronic diseases and family history of chronic conditions.

Anthropometric measurements

- Height, weight and BMI

Blood tests

- FPG, HbA1c, total cholesterol, TG, HDL and LDL cholesterol
- The level of PA
- Diet

2.2.7 Data Collection Procedure

Data collection was conducted on secondary data from 1,120 participants in 2013. Funding was granted by the National Research Foundation (NRF). We selected relevant and previously validated questions from the WHO STEP Surveillance (STEPS) Questionnaire. The questions were culturally adapted and piloted on a sample of the participants (n=12) after being translated into Arabic. We also relied upon a shortened version of the International Physical Activity Questionnaire (IPAQ). A copy of this questionnaire has been included in the appendix.

The pilot study was scheduled for two weeks in July 2013 on a randomly selected sample of 12 participants form the original 866. Satisfactory results were obtained from the pilot study in terms of ensuring that all the nurses understood the

questions and in the same way. In addition, the time required to complete the survey was determined and respondents were apparently comfortable with the questions.

Training workshops for the nurses were conducted in August, 2013 (4). These sessions informed the nurses of the purpose of the study and trained them in standardizing anthropometric methods prior to data collection. The workshop was run by qualified trainers. After the workshop, the nurses identified those from the 1,120 participants who met the inclusion criteria. A total of 254 participants were excluded as they did not meet these criteria.

The 866 participants who met the criteria were invited to take part in the study. This number took into account the fact that there would be some who would not agree to participate. The invitation was conducted along these lines: every week 50 subjects received SMS messages inviting them to attend Al Muwaiji Healthcare Center in Al Ain. They were asked to come to the center after fasting in order to do an investigation of their blood samples. The SMS messages were followed up by phone calls in order to ensure attendance. The invitations were sent out by a coordinator and four staff nurses from the center. The invitations were sent out over a six month period and resulted in 440 participants agreeing to become involved out of the possible 866. In order to increase the number of participants, UAE national medical students (n=5) from UAE university were informed of the study protocol and asked to call participants who did not respond to the first invitation. As a result, 165 more participants agreed to take part in the study, making the final number up to 605.

The 261 who did not participate in the study did so for a variety of reasons including: refusal to participate (71) and no response (186), despite two reminders. Four subjects were excluded as they were not fasting when they came to the center.

The 605 participants attended Al Muwaiji Healthcare Center for an evaluation and a blood test. Thus, the response rate was 54%. The data collection was conducted by a coordinator and trained nurses. They administered questionnaires, took measurements and collected blood samples. See Figure 2.

We used a structured questionnaire and selected relevant and valid questions from the WHO STEP Surveillance (STEPS) Questionnaire. The questions were culturally adapted and piloed on a sample of parents (n=12) after being translated into Arabic. We also included a shortened version of the International Physical Activity Questionnaire (IPAQ). A copy of this questionnaire has been included in the appendix.

A SECA adult portable stadiometer was used to measure the participants' height after they had removed shoes, socks, slippers and any headgear. It was measured in centimeters to within 0.1 cm. The SECA digital scale was used to measure their weight, and the scale was regularly calibrated against a standard weight. The participants were asked to remove footwear and socks and their weight was recorded in kilograms to within 0.1 kg. BMI (kg/m^2) (BMI; calculated as weight in kilograms divided by height in meters squared). Subjects were classified as being of a normal BMI if less than 25 (BMI <25.0 kg/m^2), the overweight category included those with a BMI of 25 to 29.9 (BMI 25.0-29.9 kg/m^2), and the obese group was those with a BMI of 30 or greater (BMI ≥30.0 kg/m^2).

WC was also measured by using a flexible, non-stretch nylon tape measure (SECA Hamburg, Germany) while subjects were lightly clothed. It was done in centimeters to the nearest 0.1 cm at the midpoint between the inferior margin of the last rib and the iliac crest in the mid-axillary plane. Hip measurements were taken around the widest portion of the gluteal muscles in centimeters to the nearest 0.1 cm

with the tape parallel to the floor. This was done while the individual was standing with his or her feet close together, at the end of a normal expiration, with the arms relaxed at the sides. Each measurement was repeated twice, and if the measurements were within 1 cm of one another, the average was calculated. If the difference between the two measurements exceeded 1 cm, then the two measurements were repeated. We used a WC of >94 cm for men and >80 cm for women to define central obesity.

We also measured resting brachial BP. A trained research nurse carried this out using a calibrated automated device (Omron HEM-705cp). The subject was in a sitting position with an appropriate sized cuff applied to the upper right arm after a five minute period of rest. BP was measured trice. The first value was discarded and the average of the two subsequent measures was used for analytical purposes. Hypertension was defined as a mean systolic ≥BP 140, a mean diastolic BP ≥90 or a if the subject was currently undergoing hypertension treatment with prescription medication.

PA was assessed by using the International Physical Activity Questionnaire (IPAQ). The activity level was measured using the intensity level, which is the rate at which the activity is performed or the extent of the effort needed to achieve an activity or exercise. The PA level can be classified into three levels: vigorous, moderate and light. ‘Vigorous-intensity activities’ require hard physical effort and cause a large increase in breathing or heart rate, ‘moderate-intensity activities’ require moderate physical effort and cause a small increase in breathing or heart rate, and ‘light-intensity activities’ do not achieve the aforementioned levels of activity. Participants were classified as sufficiently active if they exceeded the minimum recommended duration for PA per week according to WHO standards, i.e. 150 minutes of moderate intensity PA, or 75 minutes of vigorous intensity PA, or an equivalent combination of moderate

and vigorous intensity PA per week, with each activity performed for at least 10 minutes.

For biochemical measurements (HbA1c, lipid profile and FPG), venous blood samples were taken from individuals, after 10-12 hours of overnight fasting, during their visit to the Al Muwaiji Healthcare Center. 5 ml of venous blood was taken while in a sitting position. It was then immediately centrifuged to separate the serum, and transferred under cold chain conditions within less than three hours from collection, to Tawam Hospital Laboratory in Al Ain for analysis.

Biochemical tests were then conducted to measure fasting blood glucose, total cholesterol, TG, HDL and LDL cholesterol. The blood tests results generated an electronic medical report at Tawam Hospital. Two different cut-off points were used to define prediabetes: FPG ≥100 mg/dl and <126 mg/dl and FPG ≥110 mg/dl and <126 mg/dl or an HbA1c level of 5.7-6.4%. DM was defined by as a previous diagnosis of DM or, if DM had not been diagnosed previously, the ADA guidelines for DM (HbA1c = 6.5% or greater, or FPG of 126 mg/dl) were used. The National Cholesterol Education Programme guidelines define dyslipidemia in the following way: Hypercholesterolemia-serum TG levels of ≥150 mg/dl and/ or a Hypercholesterolemia-serum cholesterol level of <200 mg/dl. The optimal HDL cholesterol level was <100 mg/dl and the LDL cholesterol level was <40 mg/dl.

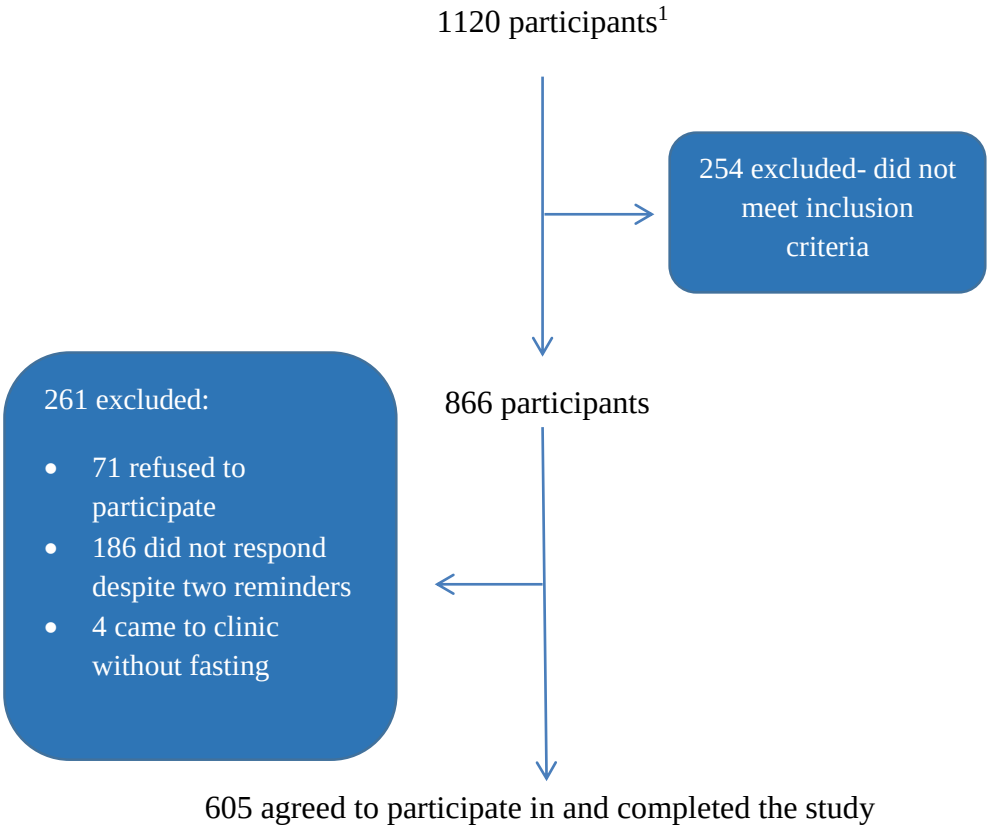

Figure 2: Summary of secondary data collected in Al Ain, Abu Dhabi, the UAE (n=605) for this dissertation

1. The 1,120 participants were parents of students from the previously mentioned study. Their contact numbers were noted when they attended Al Muwaiji Healthcare Center in Al Ain to collect blood results for their children. When we got further funding (an NRF grant) we invited the parents, via SMS message and a telephone call, to come to Al Muwaiji Healthcare Center in Al Ain for their own examination and test. Either the father or mother was selected for the study based on whoever came to collect the blood test. If both parents came then both of them were involved after obtaining consent.

2.2.8 Ethical Considerations

2.2.8.1 Ethical Approval of Study

Ethical approval was obtained from the Human Research Ethics Committee in the College of Medicine and Health Sciences, UAE University (13/09, Appendix 1).

2.2.8.2 Informed Consent

Every participant who agreed to join the study, provided written informed consent before taking part, see Appendix 6.

2.2.8.3 Confidentiality

The data and questionnaires were stored in the Institute of Public Health at UAE University with their data protection guaranteed. Thus the confidentiality of this data was preserved. To maintain anonymity, unique personal identification numbers were assigned to each participant in order to conceal the identities of the participants.

2.2.9 Data Analysis

The statistical analysis was carried out by using the STATA version 14.0 in order to calculate the prevalence of DM and prediabetes. We used Microsoft Access to enter the data before it was imported into STATA version 14.0 (StataCorp LP, College Station, TX) for analysis. The categorical variables were summarized by proportions, while the continuous variables were summarized by using mean and standard error, whichever was most applicable, with 95% confidence intervals. A Chi-square test compared proportions across groups and an ANOVA test compared the means across the groups. We used univariate and multinomial logistic regression analysis to determine the correlates for prediabetes. Variables entered into the multivariable multinomial logistic regression models were selected according to their significance ($p<0.2$) in the univariate analysis.

Multivariate analysis was used as our dependent variable had three categories (normoglycemia, DM and prediabetes). In addition, we controlled confounding information by using a multivariate analysis. We checked the data for interactions but could not find any between the variables in our study.

Design effect is important in cross sectional study. Therefore, probability proportional to size, (when samples from different sized sub-groups are used and

sampling is done with the same probability, the chances of selecting a member from a large group are less than the chances of selecting a member from a smaller group), takes varying sample sizes into account. This was not taken into consideration when choosing our target population, therefore our data may be under-representative of the general population in the UAE.

2.2.10 Timeline

The data was collected in a six-month period, from September 2013 to June 2014.

2.3 Results

The demographic and clinical characteristics of the study population are presented as a percentage for the categorical variables and as a mean±standard deviation for the continuous variables in Table 2.1.

Table 2.1: Demographic and clinical characteristics of the study population (n=605) in Al Ain, Abu Dhabi, the UAE

Variables	All	Male	Female
Emirati	52.6	39.3	60.7
Arab	47.4	51.9	48.1
Age (mean±std)	42.9±7.9	45.9±8.2	40.3±6.8
Married	95.5	98.9	94.8
Divorced or widowed	4.5	1.1	5.2
No formal education	7.1	4.4	9.1
Up to secondary level	47.1	46.1	48.1
>Secondary level	45.8	49.5	42.8
Employed	47.8	82.5	72.8
Unemployed	52.2	17.5	27.2
BMI (mean±std)	31.1±8.4	30.4±9.8	31.1±8.4
Height (mean±std)	162.9±10.3	169.9±9.8	157.1±6.3
Weight in kg (mean±std)	81.1±17.5	86.7±16.7	76.5±16.7
Waist in cm (mean±std)	91.8±13.2	98.8±10.8	85.9±12.1
Hip circumference in cm (mean±std)	105.7±10.1	103.9±8.5	107.1±11.1
Total cholesterol (mg/dl)	88.2±18.0	88.2±19.8	88.2±16.2q
LDL-cholesterol (mg/dl)	57.6±28.8	59.4±37.8	55.8±14.4
HDL-cholesterol (mg/dl)	19.8±7.2	7.2±3.6	23.4±7.2
TGs (mg/dl)	25.2±16.2	30.6±19.8	21.6±14.4
No	42.9	42.4	43.5
Yes	57.1	57.6	56.5
No	74.9	49.6	95.8
Yes	25.1	50.4	4.2
No	29.3	29.2	29.3
Yes	70.7	70.8	70.7
No	21.2	21.2	21.1
Yes	78.8	78.8	78.9
No	41.5	31.4	49.8
Yes	58.5	68.6	50.2
Under 25	14.1	14.1	14.1
25-29.99	35.7	39.1	33.1
≥30.0	50.2	46.8	52.8
Normoglycaemia	43.6	37.2	48.9
Prediabetes	37.7	40.2	35.7
DM	18.7	22.6	15.4

2.3.1 Baseline Demographic Characteristics of the Study Population

Participants were divided into two groups, based on their nationality – Emirati or Arab (52.6% and 47.4%, respectively, *P*=0.002). The mean age of the study population was 42.9±7.9 years, with a range from 35 to 50.8 years. The average age of the male participants was significantly olderthan the female ones (45.9 vs. 40.3, *P*<0.001). The percentage of married participants was 95.5%, while 4.5% of the study population were divorced or widowed. The level of education varied from no formal education, up to secondary level and higher than secondary level (7.1%, 47.1%, and 45.8%, respectively). The employment status was significantly different between the employed and unemployed participants (47.8% and 52.2%, respectively, P<0.001).

2.3.2 Baseline Clinical Characteristics of the Study Population

Table 2.1 shows the characteristics of the study population. The mean values for total cholesterol (mg/dl), LDL-cholesterol (mg/dl), HDL-cholesterol (mg/dl), and TG (mg/dl) were significantly different between the male and female subjects (*P*<0.003). The percentage of participants with no family history of DM was 42.9%, whereas the percentage of participants who had never smoked cigarettes was 74.9%. Based on the body mass index categories, 14.1% of the participants were found to have a BMI of <25, 35.7% had a BMI between 25 and 29.9, whereas 50.2% had a BMI of ≥30.0 and were classed as obese (Figure 3). Furthermore, females were more often obese than males, while more male subjects were classified as overweight than female participants (Figure 4). The mean WC (WC >=94cm male >=80 cm female) was 91.8±13.2 cm. The average WC of the male participants was significantly different from that of the females (98.8 vs. 85.9, P<0.001).

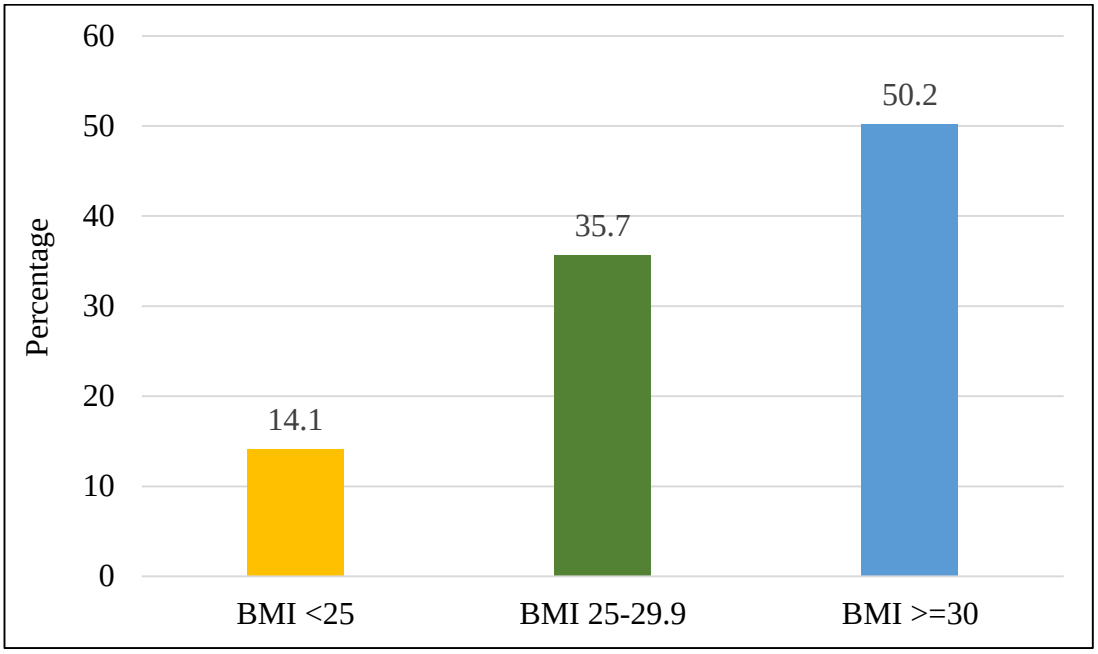

Figure 3: The percentage of body mass index categories (n=605), in Al Ain, Abu Dhabi, the UAE

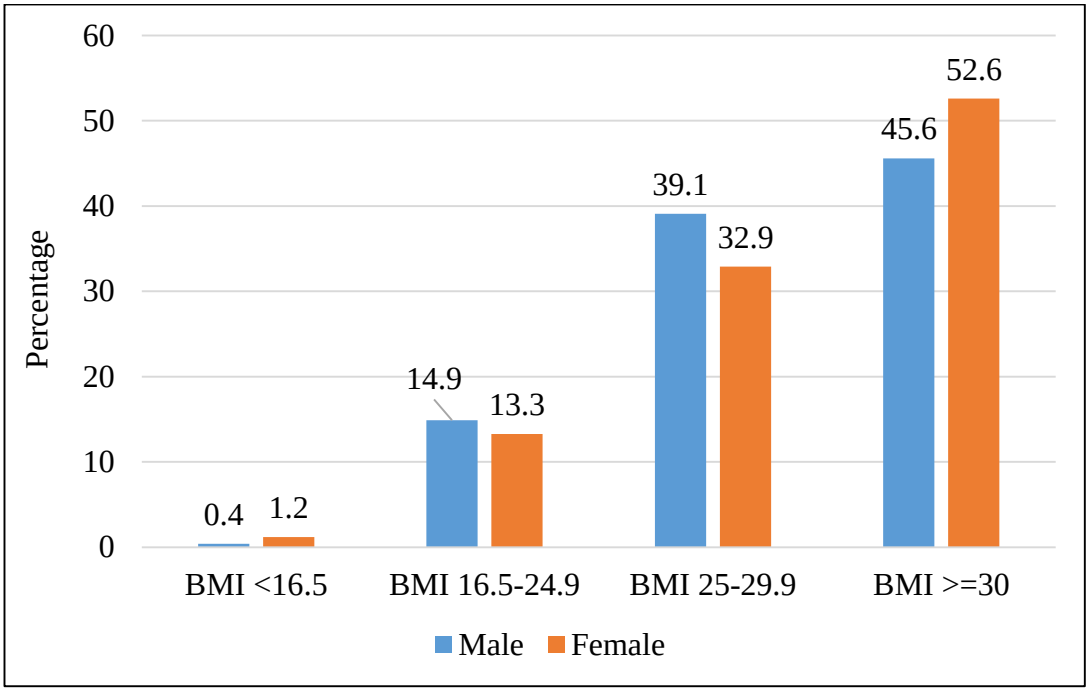

Figure 4: The percentage of body mass index categories by gender (n=605), in Al Ain, Abu Dhabi, the UAE

2.3.3 Baseline PA Level

About 71% of the study participants reported that they did vigorous PA, 78.8% stated they practiced moderate PA, and 58.5% reported walking for at least 30 minutes once a week.

2.3.4 Prevalence of DM and Prediabetes

Overall, the unadjusted prevalence of DM and prediabetes using the HA1c and FPG definition was 18.7% (CI 15.7-21.9) and 37.7% (CI 33.9-41.6), respectively. The unadjusted prevalence of DM and prediabetes was higher in males than in female subjects (22.6% of males had DM and 40.2% had prediabetes). The percentage of normoglycaemic participants was 43.6% (Figure 5).

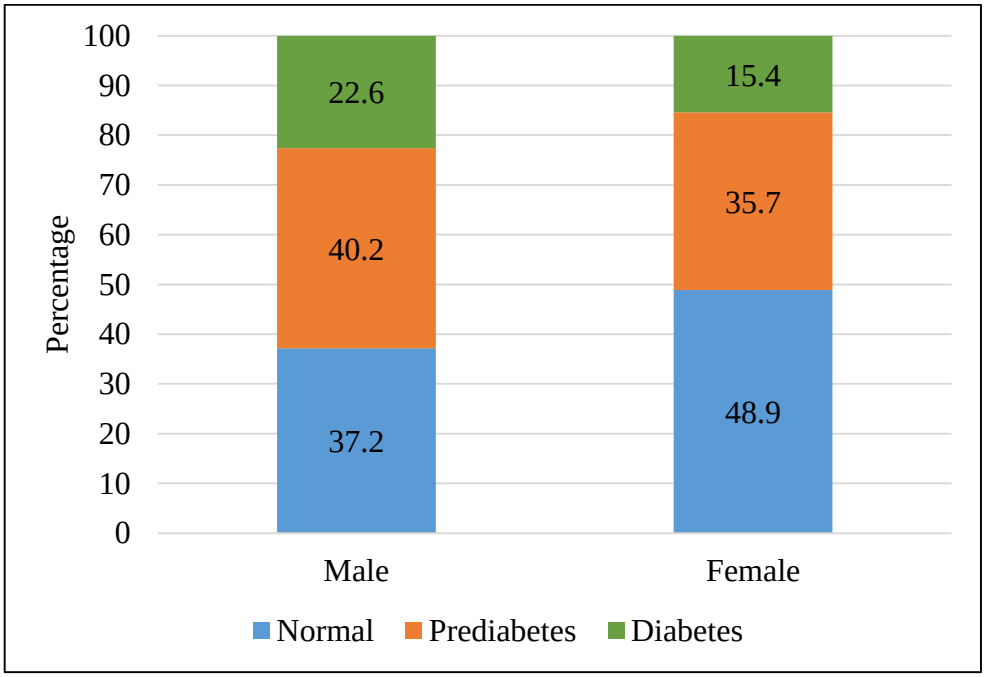

Figure 5: Proportion (%) with normoglycemia, prediabetes and DM by gender (n=605), in Al Ain, Abu Dhabi, the UAE

We further calculated the age-standardized prevalence of DM and prediabetes based on the HA1c and FPG definition. The percentage of participants diagnosed with

DM and prediabetes increased significantly as the participants got older. Univariable analyses (Table 2.3) showed that the older participants (≥55 years) were 26 times more likely to have DM, and three times more likely to have prediabetes than he younger participants (*P*<0.006).

We have further subdivided the prevalence of prediabetes and DM by BMI (using WHO criteria for BMI), and central obesity (WC >=94cm male >=80 cm female). The prediabetic participants were more often obese and overweight and had a higher percentage of central obesity when compared participants with DM (Figures 6, 7).

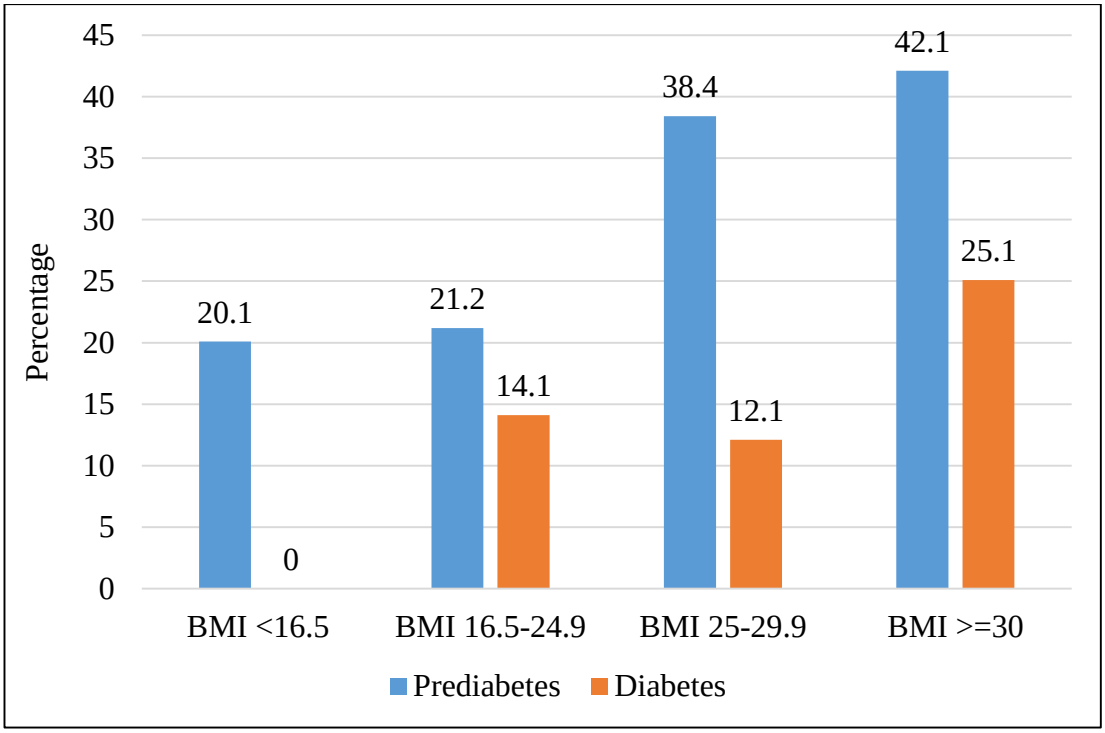

Figure 6: Prevalence of DM and prediabetes (%) by BMI categories (n=605), in Al Ain, Abu Dhabi, the UAE

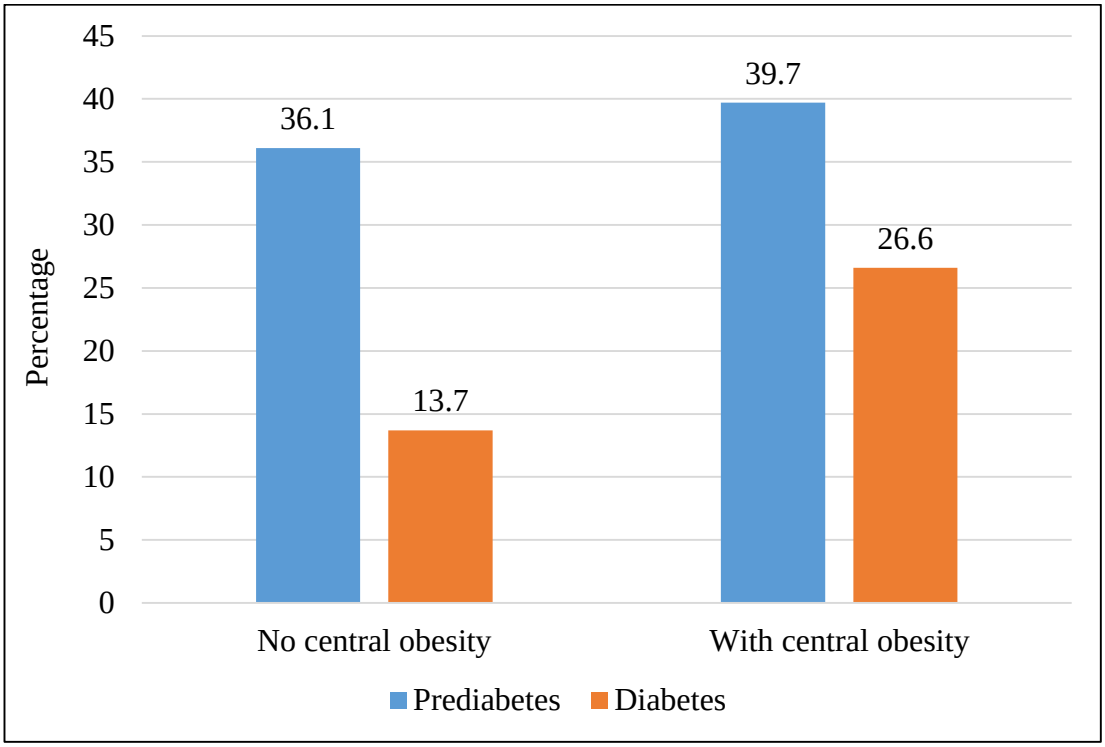

Figure 7: Prevalence of prediabetes and DM by central obesity (Waist circumference >=94 cm in male >=80 cm in female) (n=605), in Al Ain, Abu Dhabi, the UAE

2.3.5 Prevalence of Overweight/ Obesity

The distribution of the population by BMI categories as defined by WHO criteria and showed that 14.1% (CI 11.5-17.1) had a BMI of <25 kg/m^2; and 35.7% (CI 31.9-39.6) were overweight (a BMI between 25.0 and 29.9 kg/m^2), while 50% (CI 46.1-54.1) were obese (MBI ≥30).

Table 2.2 demonstrates that 50.1% of the study population could be classified as obese (≥30.0 kg/m^2) according to BMI. However, central obesity was also prevalent in 70.4% of the population, based on WC classification (WC >=94cm male >=80 cm female). In addition, 50.7% were found to have central obesity when WHR ≥0.90 cm for men and ≥0.85.0 cm for women were used as cut-off points.

Table 2.2: Distribution of the study population, according to different measures of obesity

Variable	N (%)	Males	Females
BMI			
Under and Normal weight (<25 kg/m^2)	84 (14.1)	14.1%	14.1%
Overweight (25.00-29.99 kg/m^2)	213 (35.7)	39.1%	33.1%
Obese (≥30.0 kg/m^2)	299 (50.1)	46.8%	52.8%
WC			
>94.0 cm (men); >80 cm (women)	426 (70.4)	70.1%	70.7%
<=94 cm (men); <=80 cm (women)	179(29.6)	29.9%	29.3%
WHR			
≥0.90 cm (men); ≥0.85.0 cm (women)	307 (50.7)	81.8%	25.1%
<0.90 cm (men); <0.85 cm (women)	298 (49.3)	18.2%	74.9%

We used multinomial logistic regression analysis to determine the association between independent variables, such as age, family history, anthropometric measures and biochemical measures, and dependent variables to determine the presence of DM and prediabetes. Table 2.3 and Table 2.4 show the univariable, and multivariable, regression analyses results for the possibility of having DM and prediabetes according to potential correlates, respectively.

Table 2.3: Univariate analyses− unadjusted odds ratios for DM and prediabetes

Variable	All	DM		Prediabetes	
	N	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Overall prevalence (n, %)	605	113(18.7)		228(37.7)	
Nationality					
Emirati	318	56 (17.6)	1	117(36.8)	1
Arab	287	57 (19.9)	1.16 (0.81, 1.65)	111(38.7)	1.24 (0.79, 1.93)
Age (n, %)					
35-54 years	447	83 (18.6)	6.54 (2.29, 18.61)	180(40.3)	2.57 (1.51, 4.39)
≥55	53	23 (43.4)	25.65 (7.57, 86.92)	17 (32.1)	3.44 (1.44 8.25)
Sex (n, %)					
Male	274	62 (22.6)	1.93 (1.23, 3.01)	110(40.1)	1.48 (1.03, 2.12)
Female	331	51 (15.4)	1.0	118(35.6)	1
Marital status					
Married	578	106 (18.3)	1.0	219(37.9)	1
Divorced widowed	20	4 (20.0)	1.15 (0.37, 3.52)	9(35.0)	0.89 (0.33, 2.45)
Family type					
Nuclear family	471	92 (19.5)	1.0	178(37.8)	
Joint family	126	18 (14.3)	0.64 (0.36, 1.15)	47 (37.3)	0.87 (0.56, 1.34)
Education level (%)					
No formal education	42	14 (33.3)	1.0	20 (47.6)	1
Up to secondary level	282	55 (19.5)	0.25 (0.10, 0.64.9)	105(19.5)	0.34 (0.14, 0.81)
>Secondary level	274	41 (14.9)	0.18 (0.07, 0.45)	101(14.9)	0.31 (0.13, 0.72)
Employment status					
Employed	316	56 (17.7)	0.88 (0.58, 1.37)	121(38.3)	1.01(0.71, 1.45)
Unemployed	289	57 (19.7)	1.0	107 37.0)	1
BMI categories					
<25	84	11 (13.1)	1	16 (19.0)	1
25.0-29.9	213	25 (11.7)	1.23 (0.56, 2.68)	83 (38.9)	2.81 (1.51, 5,26)
≥30.0	299	75 (25.1)	3.92 (1.92, 7.99)	125(41.8)	4.49 (2.43, 8.33)
WHR					
≥0.90 cm (men); ≥0.85.0 cm (women)	258	80 (26.1)	3.50 (2.18, 5.62)	118(38.6)	1.54 (1.08, 2.21)
<0.90 cm (men); <0.85 cm (women)	347	33 (11.0)	1	110(36.8)	
Central obesity (WC)					
>94.0 cm (men); >80 cm (women)	324	63 (26.6)	2.89 (1.83, 4.56)	94 (39.7)	1.64 (1.13, 2.37)
<=94 cm (men); <=80 cm (women)	281	50 (13.7)	1	132(36.1)	
Family history of DM					
Yes	325	77 (23.7)	2.44 (1.50, 3.97)	124 38.1)	1.33 (0.91, 1.91)
No	245	31 (12.6)	1	92 (37.5)	

Table 2.3: Univariate analyses− unadjusted odds ratios for DM and prediabetes (Continued)

Variable	All	DM		Prediabetes	
	N	n (%)	OR (95% CI)	n (%)	OR (95% CI)
Ever smoked cigarettes					
Yes	152	32 (21.0)	1.61 (0.07, 2.68)	68 (44.7)	1.73 (1.14, 2.63)
No	453	81 (17.8)	1	160 (35.3)	1
Total cholesterol (mg/dl)					
<200	377	76 (20.2)	1	130 (34.5)	1
≥200	228	37 (16.2)	0.89 (0.56, 1.43)	98 (42.9)	1.38 (0.96, 1.99)
LDL-cholesterol (mg/dl)					
<130	377	84 (22.3)	1	118 (31.3)	1
≥130	226	29 (12.8)	0.68 (0.41, 1.11)	108 (47.8)	1.79 (1.25, 2.59)
HDL-cholesterol (mg/dl)					
Normal	151	18 (11.9)	1	47 (31.1)	1
Low (<40 in male <50 in female)	454	95 (20.9)	2.55 (1.44, 4.49)	181 (39.8)	1.86 (1.23, 2.81)
TGs levels (mg/dl)					
Normal	434	65 (14.9)	1	160 (36.9)	1
High (≥150)	171	48 (28.1)	2.80 (1.74, 4.52)	68 (39.8)	1.61 (1.07, 2.43)
Hypertension (BP ≥140/90)					
No	493	77 (15.6)	1	184 (37.4)	1
Yes	112	36 (33.0)	3.60 (2.08, 6.23)	43 (39.4)	1,79 (1.08, 2.98)
PA (vigorous) at least once a week					
No	428	90 (21.0)	2.06 (1.22, 3.47)	165 (38.5)	1.38 (0.93, 2.03)
Yes	177	23 (12.9)	1	63 (35.6)	1
PA (moderate) at least once a week					
No	477	92 (19.3)	1,23 (0.71, 2.15)	179 (37.5)	1.03 (0.66, 1.58)
Yes	128	21 (16.4)	1	49 (38.3)	1
Walk for at least 30 minutes once a week					
No	139	26 (18.7)	0.84 (0.50, 1.42)	44 (31.6)	0.68 (0.44, 1.04)
Yes	466	87 (18.6)	1	184 (39.5)	1

Table 2.4: Multivariable multinomial logistic regression analysis− adjusted odds ratios (AOR) for DM and prediabetes

Variable	DM		Prediabetes
	Adjusted ORs (95%CI)	*P* value	Adjusted ORs (95% CI)
Age			
18-34 years	1.0		1.0
35-54 years	5.74 (1.91, 17.29)	0.002	2.44 (1.34, 4.47)
≥55	18.83 (4.97, 71.27)	<0.001	3.10 (1.10, 8.74)
Education level			
No formal education	1.0		1.0
Up to secondary level	0.27 (0.09, 0.78)	0.015	0.37 (0.14, 0.90)
>Secondary level	0.15 (0.05, 0.45)	<0.001	0.27 (0.10, 0.74)
WHR			
≥0.90 cm (men); ≥0.85.0 cm (women)	2.24 (1.27, 3.91)	0.005	1.01 (0.65, 1.53)
<0.90 cm (men); <0.85 cm (women)	1.0		1.0
BMI			
<25.0	1.0		1.0
25.0-29.9	1.05 (0.43, 2.55)	0.922	2.51 (1.24, 5.12)
≥30.0	3.54 (1.55, 8.07)	0.003	4.52 (2.25, 9.08)
Cigarette smoking			
No	1.0		1.0
Yes	1.04 (0.56, 1.92)	0.990	1.92 (1.18, 3.11)
TGs levels (mg/dl)			
Normal	1.0		
High (≥150)	2.09 (1.22, 3.61)	0.008	1.28 (0.81, 2.03)
Vigorous PA once a week			
No	1.96 (1.06, 3.62)	0.031	1.31 (0.85, 2.00)
Yes	1.0		
Family history of DM			
Yes	2.95 (1.66, 5.23)	<0.001	1.26 (0.84, 1.88)
No	1.0		1.0

2.3.6 Number of People Diagnosed with Prediabetes and DM

Figures 8 and 9 show the percentage of participants who were diagnosed with prediabetes and DM by a doctor's diagnosis or by HbA1c or FPG.

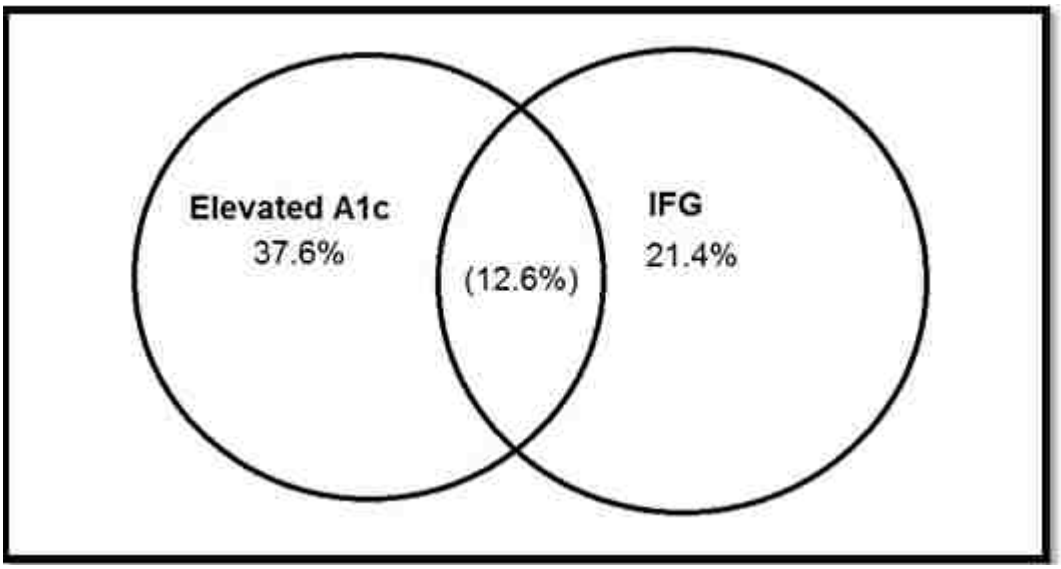

Figure 8: Percentage of participants diagnosed with prediabetes using HbA1c or FPG

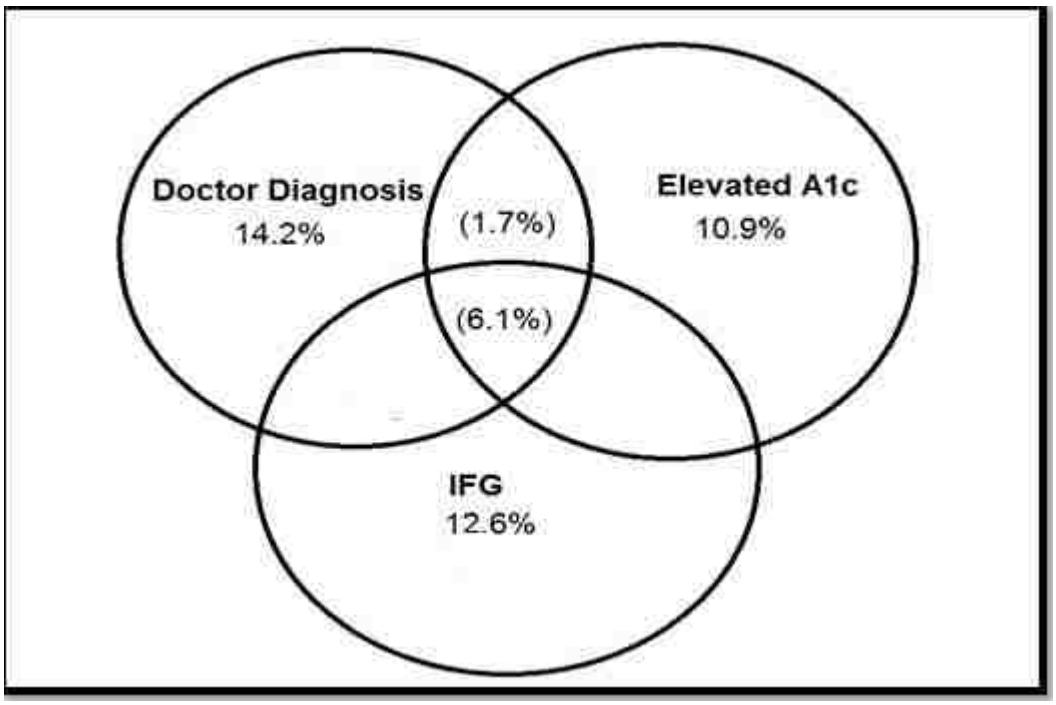

Figure 9: Percentage of participants diagnosed with DM by a doctor's diagnosis or HbA1c or FBG

2.3.7 Association between Prediabetes, DM and Age

In the univariable analyses, study participants were more likely to belong to older age categories (≥55 versus 18-34 years) with DM (odds ratio [OR] =25.65; 95% CI 7.57 to 86.92) as well as with prediabetes ([OR] =3.44; 95% CI 1.44 to 8.25) as compared to their normoglycemic counterparts. Moreover, this correlation remained significant in the multivariable analyses for both DM (adjusted odds ratio [a OR] =18.8; 95% CI 4.9 to 71.2, P<0.001), and prediabetes ([a OR] =3.10; 95% CI 1.1 to 8.7, P=0.032), respectively.

2.3.8 Association between Prediabetes, DM and Education Level

Participants with DM were less likely to report having a formal education (OR=0.18; 95% CI 0.00 to 0.4). The same was applicable for prediabetes (OR=0.3; 95% CI 0.1 to 0.7), when compared to participants with normoglycemia in the univariable analyses. This remained significant in the adjusted analyses for DM (aOR=0.1; 95% CI 0.0 to 0.4) and prediabetes (aOR=0.2; 95% CI 0.1 to 0.7).

2.3.9 Association between Prediabetes, DM and Waist Hip Ratio

Participants were more likely to have a WHR of more than 0.90 cm in men and ≥0.85.0 cm in women if they had DM (OR=3.5; 95% CI 2.1 to 5.6) or prediabetes (OR=1.5; 95% CI 1.0 to 2.2) in univariable analyses, as compared to those with normoglycemia. In the multivariable analysis (Table 2.4), the correlation of WHR with prediabetes was not significant (p<0.0991). However, a high WHR remained a significant correlate of DM.

2.3.10 Association between Prediabetes, DM and Obesity

Participants with DM were more likely to be obese (OR=3.9; 95% CI 1.9 to 7.9) and, similarly, participants with prediabetes were more likely to have obesity issues (OR=4.4; 95% CI 2.4 to 8.3), than those with a normal FBG level in the univariable analysis. These findings remained significant even after adjusting for other potential confounding data. This was true for both DM (aOR=3.5; 95% CI 1.5 to 8.0) and prediabetes (aOR=4.5; 95% CI 2.2 to 9.0).

2.3.11 Association between Prediabetes, DM and Smoking

Participants with DM and prediabetes were 1.61 more likely to smoke cigarettes. OR=1.61; 95% CI 0.07-2.6 for diabetes, and OR 1.73; 95% CI 1.14-2.63 for prediabetes when compared to participants with normoglycemia, in univariable analyses, This was also significant in the adjusted analyses for prediabetes (aOR=1.9; 95% CI 1.1 to 3.1; P=0.008) but not for DM (aOR=1.0; 95% CI 0.5 to 1.9; P=0.990).

2.3.12 Association between Prediabetes, DM and TGs Levels

Elevated TGs levels (≥150mg/dl) showed a significant association with DM (OR=2.8; 95% CI 1.7 to 4.5; $P<0.001$) and prediabetes (OR=1.6; 95% CI 1.0 to 2.4; $P=0.022$) in univariable analyses. This remained significant for DM in the adjusted analyses (aOR=2.09, 95% CI 1.2 to 3.6; $P=0.008$), but not for prediabetes (aOR=1.28, 95% CI 0.8 to 2.0; $P=0.286$).

2.3.13 Association between Prediabetes, DM and Physical Activity

Not practicing vigorous PA at least once a week had a significant correlation to the presence of DM (OR=2.06; 95% CI 1.2 to 3.4; $P=0.007$), but not for prediabetes

(OR=1.3; 95% CI 0.9 to 2.0; *P*=0.103) in the univariable analyses when compared to those with normoglycemia.. This effect remained significant for DM in the adjusted analyses (aOR=1.96, 95% CI 1.0 to 3.6; *P*=0.031).

2.3.14 Association between Prediabetes, DM and a Family History of DM

Participants with DM were 2.4 times more likely to report that they had a family history of DM (OR=2.44; 95% CI 1.5 to 3.9, P<0.001) as compared to their non-DM counterparts, in the univariable analyses. Again, this remained significant in the adjusted analyses for DM (aOR=2.95; 95% CI 1.6 to 5.2; P<0.001). However, no association was found between prediabetes and a family history of DM.

2.4 Discussion

2.4.1 Prevalence of Prediabetes

In this cross-sectional study in the UAE, we estimated the prevalence of DM and prediabetes and quantified the effect of correlating conditions associated with individual characteristics. Our findings suggest that DM and prediabetes have become epidemic in the UAE's adult population. We also found that the prevalence of DM and prediabetes varied substantially with the individual's age, educational level, WHR, body weight, TGs levels and PA.

The study described here measured the prevalence of prediabetes in Al Ain using the ADA 2016 recommended prediabetes diagnostic criterion of an HbA1c level of 5.7% to 6.4%, and an FBS level of 100 mg/dl to 125 mg/dl[1]. It demonstrated that the prevalence of prediabetes in Al Ain was significant and amongst the highest reported globally. The reported prevalence of prediabetes was 37.7% in the study

group, which was similar to the figure reported in 2012 for the US adult population (38%)[30]. However, it was much higher than the prevalence reported in a population-wide cardiovascular screening program (Weqaya) in Abu Dhabi in 2012, where the incidence of prediabetes was 27%[41]. This is probably because of differences in the sample size and characteristics. For example, in our study, participants were married and older than the population in the Weqaya study. In addition, participants in the Weqaya study included different demographic characteristics such as single people and people without children.

The high prevalence of prediabetes in our study should alert policy and decision makers to the seriousness of the problem. Unless urgent prevention efforts are successfully implemented the prevalence of prediabetes will increase even further, and each new case of DM in the UAE will exacerbate future economic and health burdens on the country.

Despite the fact that the incidence prediabetes differs depending on the diagnostic criteria, our study's findings are consistent with the increase in prediabetes across the GCC[38,39], Asian[33,37,152], European[32] and North American[27,31] countries. Roughly similar figures have recently been reported in the US (37%)[153], in the UK (35.3%)[32], Oman (35%)[39] and Canada (33.1%)[31]. However, a lower rate was found in Saudi Arabia (11.9%)[38] and Bangladesh (11.5%)[37]. It can be predicted from the substantially higher prevalence of prediabetes in the UAE that there will be a further increase in DM over the next few years. It also illustrates that prediabetes in the UAE offers an urgent context for preventative intervention, especially as worldwide evidence indicates that lifestyle modification can not only prevent the onset of prediabetes, but also help patients to revert to a normoglycemia status[43,154]. In addition,

effective intervention at the prediabetic stage can lead to a slowing down of the high economic and health burden ($60 million per year in the UAE), or even help to prevent it[42].

The prevalence of prediabetes was higher among men (40.2%) as compared to women (35.7%), even though there were more obese women (52.8%) than men (46.8%). Similar findings were reported in the Weqaya study, where 27.8% of men, compared to 26.5% of women had prediabetes despite the fact that 38% of women and 32% men were obese[41]. Our study also showed that obese people were 4.4 times more likely to have prediabetes than those of a normal weight. This relationship indicates that despite obesity being related to prediabetes in the UAE, the extent of the effect of obesity on prediabetes is not the same for men and women. There is a difference in gender-related factors that can affect prediabetes. In a longitudinal population-based study in China, it was found that PA in males and WC in females were important predictors and causes of prediabetes[155]. Identifying the most common reasons for prediabetes in both men and women is vital in order to inform preventative measures and any attempts to return patients back to normal glucose regulation.

2.4.2 Association between Prediabetes and Age

Our findings showed that age (non-modifiable), obesity, WHR, TGs levels, PA and educational level (all modifiable) were significantly associated with prediabetes. The current analysis showed a high proportion (40%) of people aged 34-54 years had prediabetes as compared to participants from the younger age categories of 18-34 (26%). This age-specific finding supports the need for early detection and periodic screening in people aged 34-54 years. This priority group also needs to be the target of more lifestyle education programs that highlight the importance of increased regular

PA, a healthy diet, self-monitoring of their BMI and periodic FBG checks. These can be performed in the workplace, or in outpatient clinics in a primary health care setting.

The ADA suggests there should be prediabetic screening of asymptomatic adults of any age who are overweight or obese (BMI ≥25 kg/m^2) and have one or more additional correlate for DM, like being from a high-risk race, physical inactivity, having first degree relatives who have DM, high BP or hyperlipidemia[154]. The above age-specific finding in this study also suggests that published information from the WHO or ADA regarding prediabetes screening should can be taken as a general guideline, but that each country needs to have its own, more population specific, guidelines.

2.4.3 Association between Prediabetes and Obesity

As expected, obesity was one of the most important correlates that was significantly associated with prediabetes. The distribution of the population per BMI category showed that 35.7% were overweight (BMI between 25.0 and 29.9 kg/m^2), and 50.1% were obese (MBI ≥30 kg/m^2). In the univariable analysis, participants who were obese were 4.5 times more likely to have prediabetes than those of a normal weight. This relationship has also been demonstrated in other studies, including in Saudi Arabia and Bangladesh[37,38,156].

The results of this study indicate that there has been an extremely rapid rise in the proportion of adults who meet the criteria for obesity. The most recent reports from the UAE show a sharp rise (double) in the prevalence of obesity in adults (from 16% to 35%), with grade III obesity (BMI ≥40) rising the most dramatically from 2% in 2000 to over 11% in 2010[157]. This is nearly four times higher than the increase

observed in the proportion of people with morbid obesity in the UK (from 1.8% to 2.9% between 2005-2015)[95]. The figure obtained in our study for the prevalnce of obesity (50.1%) is alarming as it is higher than the one reported in the Weqaya study (35%) and in other UAE cross-sectional surveys, which revealed an overall obesity rate in the UAE of 34%[41] in 2000. Our results are consistent with previous studies in other GCC countries where there has been an increase in obesity in recent years. This suggests that the lifestyle in the GCC countries is conducive to encouraging obesity. However, this increase was lower than the rise observed in Saudi Arabia (39%) and Kuwait (42%)[103] in our study. It compares badly to the prevalence of obesity in England (27%)[95] and Bangladesh (4.6%)[97].

The UAE has been ranked as the world's fifth most obese nation[158]. A number of factors at an individual and environmental level, mainly dietary and physical inactivity, have contributed to rising numbers of overweight people and obesity in the UAE[121]. Adults in the UAE consume over 3,000 calories per day on average, more than 20% over the recommended daily allowance[158]. The daily fruit and vegetable consumption in the UAE is not optimal either[130]. Between 1998 and 2003, approximately 80% of males and over 75% of females in the Emirates reported eating less than the recommended five daily servings of fruit and vegetables[158]. Skipping breakfast is also highly prevalent in the UAE[119] (28% of Emirati boys and 37% of Emirati girls) and consumption of fast food has increased (76% consumed fast food at least once per week)[145]. The number of fast food restaurants in the food courts of shopping malls and petrol stations has increased in the UAE. Furthermore, the consumption of sugar-sweetened drinks has also increased[130] (making up 8%-14% of the total calorie intake and 70% of the daily liquid intake[158]). This is still below the

US, UK, and Mexico. In Saudi Arabia, two-thirds of males and adolescent females consume sugar-sweetened drinks more than three days per week[119]. Snacking (1.5 snacks per day) represents a very large proportion of the calories (20%)[158] consumed by UAE nationals. In comparison the US population consumes 3 snacks a day on average. However, Emiratis eat more calorie dense foods and have longer snack periods when compared to Americans[157].

There is a significant lack of PA in the UAE population, especially females and those living in urban areas. Only 41%[121] of adult Emirati women take moderate, or high, levels of PA compared to 82%[157] and 65%[119] of American and Saudi women respectively. A lack of female role models among their peers and families, not having culturally acceptable exercise facilities for women, and the hot and dusty weather[114] all create obstacles for women who want to get involved in sports in the UAE. Other hindrances to exercise for Emirati women include a lack of information on the benefits of exercise, personal motivation and not having the spare time for exercise[123]. As a result, females spend more time indoors doing sedentary activities, including watching TV and snacking on high calorie content food[119]. Furthermore, Emiratis forgo domestic chores as these are often carried out by a domestic housekeeper, cook and nanny, which results in an even more sedentary lifestyle[159].

The environment in the UAE is obesogenic and cities are unfortunately not designed for walking. Therefore, Emiratis rely heavily on automobiles[145]. Indeed, the more urbanized areas may be even more obesogenic. In addition, the high temperatures of up to 45^0C in the Summer and the concomitant dusty conditions discourage people in the UAE from exercising[114]. Policy makers must reshape the environment in the

UAE in a way that encourages healthy decision making as this is a key feature in the prevention of obesity.

Furthermore, offering inventive social support programs to help people to make better lifestyle choices, to eat healthier diets and do more PA is required. These initiatives include improving access to a larger variety of healthier food options that are more easily available, more accessible and cheaper in price. Food courts in malls and petrol stations need to have healthy restaurants and takeaway outlets and incentives must be available to help investors who are willing to open them. For example, lower rents and utility costs. One way of limiting access to less healthy options is by imposing a sugar tax. This would create an incentive for firms to supply healthier alternatives and will also raise funds that can be used to both subsidize the price of healthy food (fruit and vegetables) and fund public educational campaigns.

Health officials should work with city planners to create a more positive built environment and design communities that promote active transport and improve access to exercise and outdoor activities. This can be achieved through building community parks, designing shopping malls with a walking track, and making roads safer for exercise. Furthermore, they should ensure that communities, especially female members, have easily accessible and reasonably priced exercise facilities that are within their cultural context. Moreover, decision makers need to encourage healthy behavior, particularly by women. This can be done by promoting a high level of PA and encouraging healthy eating from a young age. This is important because children are the most likely to adopt the lifestyle behaviors of family members, especially their mothers.

Health practitioners have a major part to play in combating obesity in the community. Their role is to continue screening for obesity by measuring and monitoring the weight of their patients (of all ages) during routine and follow-up visits to clinics.

They have a role in preventing unnecessary weight gain and encouraging healthy behaviors (PA and healthy eating), in addition to referring patients to dietitians, nutritionists, or other specialists, as required.

The Nutrition Examination Survey (NHANES) showed that the prevalence of prediabetes has increased even among adults of a healthy weight. This finding is concerning as there are no clear reasons for it. Abdominal obesity and sedentary lifestyle were two factors[160], but it was concluded that abdominal obesity was not an independent correlate. This was contrary to our finding where a WHR of >0.90 cm for men and ≥0.85.0 cm in women was associated significantly with an increase of 1.5 times in the possibility of getting prediabetes. Similar findings have been reported in Saudi Arabia[38] and China[161].

2.4.4 Association between Prediabetes and Educational Level

Educational level was among the correlates for prediabetes in our study. A high educational level was found to be positively correlated with prediabetes. Participants who reported an education level of more than secondary school were 0.3 times more at risk of developing prediabetes, compared to participants without a formal education. This finding might be explained by the fact that educated people are involved in more sedentary office work and often have an urban lifestyle, in contrast to less educated people who are more involved with manual labor and live in more rural areas. The

associations between educational level and prediabetes vary internationally. Our finding are in marked contrast to other population-based studies where prediabetes was inversely associated with educational level in Indonesia[46] and Australia[162], while in Saudi Arabia[38] and Bangladesh[37] the findings were consistent with ours. Other studies conducted in Hong Kong with Chinese people and in Iran showed there was no relationship between prediabetes and the education level of either sex, while one study in Iran showed that a higher educational level was a prediabetic correlate only in women[162].

2.4.5 Prevalence of DM

The overall prevalence of DM in our study was 18.7%, which was similar to the figure reported in a population-wide cardiovascular screening program (Weqaya)[40] in Abu Dhabi, but lower than the one reported by the International Diabetes Federation (IDF) in the UAE, (19.3%). Although earlier studies from GCC countries have indicated very similar rates of DM compared to the UAE, our study showed a higher rate than those reported in Saudi Arabia (17.6%) and Kuwait (14.3%)[163]. The prevalence of DM in the UAE is rising (13.5% in 2000 compared to 18.7% in our study) at a faster rate than in the MENA region and the rest of the world, and the number of people with DM is expected to double to 2.2 million by 2040. Many explanations exist for this high rate of DM in the UAE and other Gulf countries. The most common reasons relate to high rates of obesity, which appear to have got worse over the last few decades. Drastic measures need to be implemented at policy level in the UAE in order to both combat the DM epidemic and protect the health of the next generation.

2.4.6 Association between DM and Age

Our findings confirmed that there are many correlations for DM, including age, obesity, WHR, TGs levels, PA and education level. Older participants (≥55 years) were 25.65 times more likely to have DM, which is similar to the relationships observed around the world, including Bangladesh[98]. This finding is important as it will help decision makers and clinicians to design a screening program for the UAE population. People in this age group (≥55 years) have to be the focus before other age groups.

2.4.7 Association between DM and Education Level

Our findings showed that participants who reported their educational level was higher than secondary school had 82% less risk of DM, compared with participants without a formal education. This association varies internationally. The positive associations we found between these two factors and DM have also been previously observed in Bangladesh[154] and Brazil. In China, the prevalence of DM was generally unaffected by educational level[161] Studies from both developing and developed countries have found there are inverse associations between DM and educational level, maybe because better-educated people are more health-conscious[154].

2.4.8 Association between DM and Waist Hip Ratio

In our study, we found that having a high WHR was significantly associated with an increased risk of getting DM, compared to those with a normal weight. Other studies in Saudi Arabia[160], Kuwait[103] and Bangladesh[154] have supported this result. The prevalence of obesity has recently increased in the UAE, which is due to rapid urbanization that encourages a sedentary lifestyle and less traditional. And healthy,

diets. This finding provides decision makers with a mandate to intensify their efforts by concentrating on early intervention strategies to target obesity and central obesity in adults by increasing their control of food choices, PA and enhancing public awareness of obesity and its adverse consequences. These needs are particularly significant to the UAE as health illiteracy is very common[157].

Our findings could have important public health implications. The UAE's rapid socio-economic growth over the past 46 years has reflected positively on many of the UAE's health indicators like mortality rates and life expectancy. If this accomplishment is to last, the government has to increase its efforts and focus on proven, cost-effective primary prevention services that concentrate on behavior and lifestyle modification because of the huge growth in chronic diseases, including prediabetes, DM and obesity. In spite of the fact that preventive health services have been prioritized in the last few years, policy makers have concentrated on the provision of curative and tertiary healthcare services with little emphasis being placed on prevention. Furthermore, the existing primary healthcare services that are available in the UAE concentrate on providing immunizations and prenatal services instead of combating the increased rate of NCD, including prediabetes, DM and obesity.

2.5 Strengths of Our Study

Training workshops for nurses were conducted by qualified trainers. The training of the nurses in the use of standardized methods of anthropometric and BP measurement prior to data collection, assured the quality of the data collection. Furthermore, physical activity was assessed by using the IPAQ, which was used in conjunction with the WHO STEPS Questionnaire. Both HbA1c and FPG levels were

used to identify participants with prediabetes and DM. US National Cholesterol Education Program guidelines were used for the definition of dyslipidemia.

2.6 Limitations of Our Study

The primary limitation of this study is that it does not allow for causal conclusions regarding the relationship between the variables studied and prediabetes and DM as it is a cross-sectional study. Also, the measurement of the variables i.e. diet and physical activity was self-reported and depended on the participants' memory and accuracy. This might have led to inaccurate data, especially in relation to their family history (father and mother), who might even be deceased.

In addition, the American Diabetes Association recommends a repeat measurement after a single hemoglobin A1c, FPG, or 2-hour PG diabetes-positive test result, which we could not do because most participants made only one visit. Therefore, some participants without DM may have been misclassified as having DM and we cannot be certain how frequently this may have happened.

A potential threat to internal validity was the lack of consistency in the biometric testing procedures. For example, the weight and waist measurements were taken with clothing on, which could have led to incorrect and inconsistent results. Furthermore, design effect was not taken into consideration when choosing our target population and our study population included only married adults with school children. As such our results should be interpreted with caution as they may be under-representative of the general population of the UAE.

Chapter 3: Characteristics of Prediabetes and Correlates of Conversion from Prediabetes to DM in Dubai, the UAE

3.1 Introduction

Studies have established the use of simple clinical (weight, WC) and laboratory measurements (e.g. glucose, uric acid, lipids) to derive DM prediction models that are suitable for general practice[3]. Many studies have considered the risk factors for the conversion of prediabetes to DM[3,164,165,166]. It is generally assumed that the risk factors for prediabetes are similar to those for DM. Nevertheless, it is unclear if the strength of association of these risk factors is the same for both prediabetes and DM. The incidence of DM among those with prediabetes is higher in women when compared to men due to a low level of PA and higher obesity[3]. Prediabetes is significantly associated with being overweight or obese, hypertension, hypercholesterolemia and arthritis[66].

In the USA, the Strong Heart Study, a population-based longitudinal study of CVD and its risk factors, showed that the risk factors for DM in individuals with prediabetes was higher in women and in people with higher BMI, WC, and HbA1c who took less PA[165]. Furthermore, a retrospective longitudinal study in Japan of 2,105 adults with prediabetes, with a mean observation period of 4.7 years ,showed that the independent risk factors for prediabetes becoming DM were a family history of DM, being male, a higher than normal BP and glycaemia levels. Additionally, this study confirmed that a BMI reduction as small as 1 kg/m^2 was related to a 16% decrease in the incidence of DM in people with prediabetes[26]. Obesity was a common risk factor for the transformation of prediabetes to DM in a population-based study in Denmark

and in other studies (above). There were also other factors, like hypertension and hypertriacylglycerolaemia[167].

In the UAE, there have been several studies into the risk factors for DM in the UAE population and fewer studies on prediabetes. However, to the best of our knowledge, no study has been conducted on the predictors for the conversion of prediabetes to DM in the UAE. The results of our study will have a major impact on public health in the UAE and can be used as a guide for policy and decision makers. It will also help to shape future healthcare in the UAE.

3.1.1 Secondary Aims and Objectives

3.1.1.1 Aims

Prediabetes is associated with a significant risk of developing DM and CVD. Early screening and diagnosis of prediabetes, along with preventive measures, are essential in preventing DM or delaying its progression. Our study aims to improve current understanding of prediabetes in order to ensure early detection of DM. This would allow us to plan for better control and prevention of DM in the UAE.

3.1.1.2 Specific Objectives

- Objective 1: To identify the characteristics of Emirati adults with prediabetes.
- Objective 2: To identify the correlates which lead to the progression of prediabetes to DM in Emirati adults.

The Research Hypothesis:

People with prediabetes who reported positive symptoms related to sleep apnea on the Berlin Questionnaire Scale are more likely to develop DM as compared to their counterparts without the symptoms of obstructive sleep apnea.

3.2 Methods

3.2.1 Study Design

We used a cross-sectional design to achieve our study objectives.

3.2.2 Study Site

This study was conducted in five healthcare centers in Dubai. Dubai is the most populous city in the UAE. It is located on the southeast coast of the Arabian Gulf and covers an area of 4,110 km^2 with a population of 2.847million, according to the 2017 census.

3.2.3 Study Population

The previous data from Al Ain was sampled from other data. For this dissertation a study planning workshop was conducted in order to recruit 700 UAE nationals, aged over 18, with prediabetes from five primary healthcare centers in Dubai. Out of 700 subjects contacted, 487 participants met the inclusion criteria of the study protocols, agreed to take part and completed the questionnaires. Before reducing the sample to 700, 300 subjects had already failed to meet the inclusion criteria.

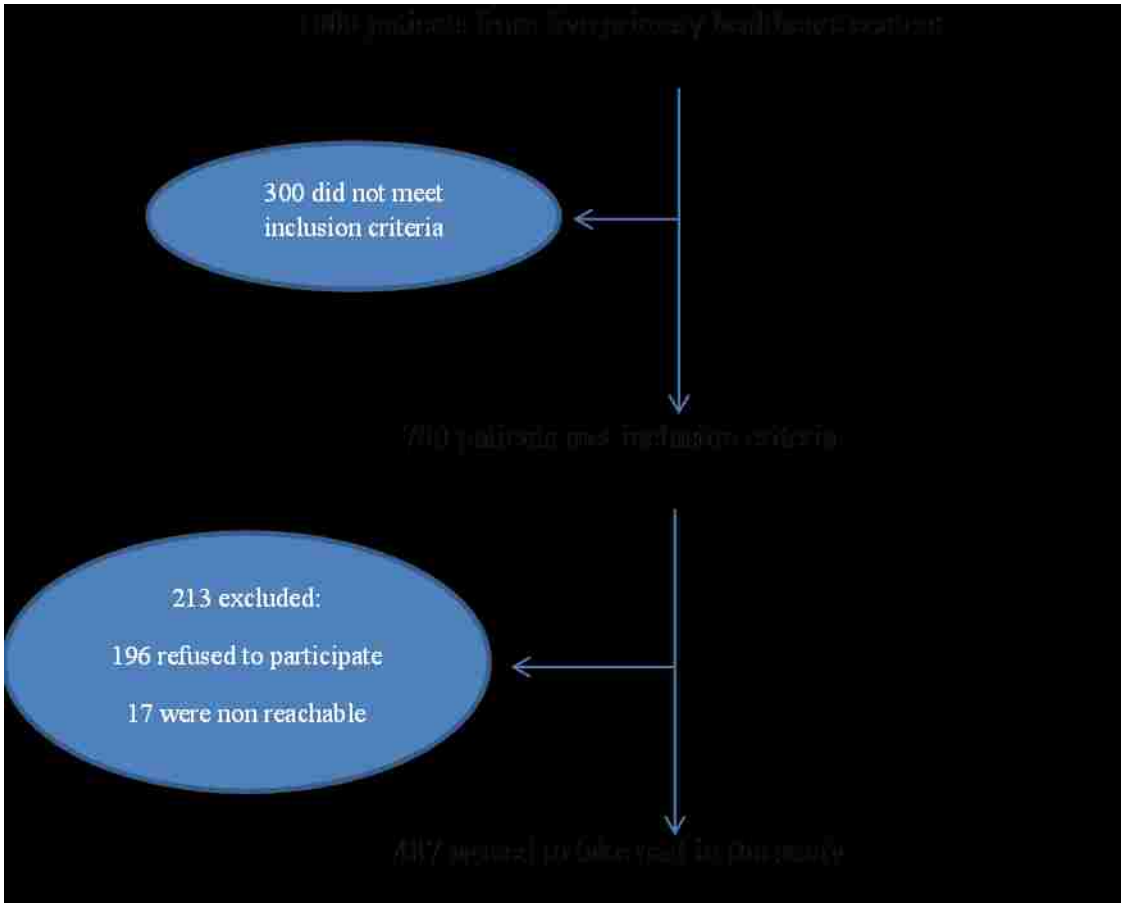

Figure 10: Study population in Dubai, the UAE (n=487)

3.2.4 Sample Size and Selection of Study Participants Correlate

Our main aim in this study was to evaluate the role of sleep apnea in the conversion of prediabetes to DM. We could not perform sleep studies in order to identify sleep apnea. However, we used the Berlin questionnaire to identify people at risk of obstructive sleep apnea.

We wanted to demonstrate a difference of a third of the (within group) standard deviation of blood sugar levels in the negative sleep apnea group, as compared to the group of prediabetics with sleep apnea with a Type I error of 5% and a Type II error of 10%. Using the standard formula for two groups with continuous outcomes, we

required 146 participants per study strand. After adjusting for clustering effects in the health care centers by using an average design effect of 1.76 (based on the largest design effect that had been observed in previous studies), and accounting for the loss to any follow-ups and retractions of informed consent, we recalculated the need for 400 study participants.

3.2.4.1 Inclusion Criteria

- Emirati national.
- Aged 18-64 years.
- Living in the Emirate of Dubai.
- Diagnosed with prediabetes (HbA1c 5.7-6.4) or (FBG 100-125 mg/dl).
- Not using any medicine for DM.
- Willing and agreed to participate.

3.2.4.2 Exclusion Criteria

- Participants aged <18 and >65.
- History of DM (self-report of a previous diagnosis by a physician or other health professional or determined from a medical report).
- Major psychiatric diseases (determined from medical report).
- Current, planned, or previous pregnancy within the past 6 months.
- Refusal to participate or withdrawal from the study.

3.2.5 Study Measurement

3.2.5.1 The Primary Variable

The primary variable was the conversion from prediabetes to DM. DM was diagnosed by self-reporting during telephone interviews, and/ or by having an FBG of >=126 mg/dl and an HbA1c >=6.5.

3.2.5.2 The Other Variable

The other variable was sleep apnea. Symptoms for sleep apnea were detected by using the Berlin questionnaire on sleep apnea.

3.2.5.3 Other Variables

Socio-demographic characteristics

- Age, tobacco use, educational level, smoking, history of chronic diseases and family history of chronic conditions.

Anthropometric measurements

- Height, Weight and BMI.

Blood Tests

- FPG, HbA1c, total cholesterol, TG, HDL and LDL cholesterol.
- The level of PA.

3.2.6 Data Collection Procedure

Dubai Health Authority (DHA) launched the Dubai Standards of Health Care on March 16th, 2015 to ensure early detection and unified management of DM and prediabetes in the Emirate of Dubai. Prediabetes screening was conducted across 18

primary health care centers. The subjects were originally 5,131 UAE nationals in Dubai in 2015. They data came from 18 healthcare centers and the subjects were identified via the electronic system SAM (electronic system available in primary healthcare centers in DHA) as part of a screening program. The screening included taking blood samples for a lipid profile, fasting blood sugar and HbA1C. The blood results were obtained from the SAM system at the DHA.

In 2017, we used a sampling frame with the data above for our current study. This time five primary healthcare centers in Dubai were chosen at random from the 18 (Simple Random Sampling). A list of the total number of patients in each of the five healthcare centers was generated. Then a study sample proportionate to the size of each of the five health centers was prepared.

Next, we conducted a workshop. The workshop included project staff, one primary health care physician and a registered nurse from each of the five centers. The study team explained the aims and objectives of the study to the workshop participants. With the help of prediabetic screening staff and workshop participants, 1000 UAE nationals with prediabetes were identified based on fasting plasma glucose and HbA1c levels, according to the ADA guidelines. The identification of possible study participations was undertaken by a nurse at each of the five centers under the supervision of a doctor (one doctor per five nurses) using the SAM system. With a grant in place from the NRF for Diabetes Prevention, 700 DHA screening program subjects were contacted to participate in a more intensive diabetes prevention program.

A team of final year female medical students at UAE university (n=12) was identified to serve as research assistants. A training workshop was also conducted for the medical students by qualified trainers, to explain the study protocol and give

training on standardizing methods for gathering data by phone call questionnaires. Participants diagnosed with prediabetes (ADA guidelines of FBG 100-125 mg/dl and A1C 5.7% to 6.4%) in our 2015 study were contacted to take part in the phone-based study.

Each subject received three phone calls after which they were excluded if no response was obtained. Verbal consent was granted by each participant at the beginning of the call. Participants who did not give their consent were excluded from the study. We used a structured questionnaire that identified socio-demographic, lifestyle and clinical data and used the Berlin questionnaire to assess the extent, or not, of symptoms of sleep apnea. The data was collected from 700 UAE nationals over the phone. Out of the 700 Emiratis who completed screening test and were diagnosed with prediabetes, 487 agreed (respond rate 69%) to complete our study questionnaire and tanswer he Berlin questionnaire to scale obstructive sleep apnea. Socio-demographic and behavioral information on tobacco use, daily consumption of fruit, PA level, history of chronic diseases, and family history of chronic conditions was also obtained. Data regarding anthropometric measurements, such as height and weight was self-reported.

Data regarding exercise behavior was determined by asking participants about the frequency and duration of their daily exercise. The PA activity was classified into three levels: vigorous, moderate and light. ‘Vigorous-intensity activities’ require hard physical effort and cause a large increase in our breathing or heart rate, ‘moderate-intensity activities’ require moderate physical effort and cause a small increase in our breathing or heart rate, and ‘light-intensity activities’ require the least amount of effort. Participants were classified as being sufficiently active if they exceeded the minimum

recommended duration of PA per week, as suggested by the WHO, i.e. 150 minutes of moderate intensity PA, or 75 minutes of vigorous intensity PA or an equivalent combination of moderate and vigorous intensity PA per week, with each activity performed for at least 10 minutes. Fruit and vegetable consumption was also measured by finding out if they ate these foodstuffs "every day" or "not every day".

Individuals were considered to have DM or high BP if a health care provider had ever told them they had hypertension or DM, or were on medication for hypertension or DM, excluding gestational diabetes. Hypertension was defined as a mean systolic BP of ≥140, a mean diastolic BP of ≥90 or if individuals had been diagnosed by a physician and were on anti-hypertensive medication (self-reported). Participants with DM were asked about the type of treatment they were on (diet, tablets or insulin injections) and if they had a device to check blood sugar levels at home. Respondents were asked whether any of their living or deceased, first or second, blood relatives (including grandparents, aunt, uncle, first cousin, parents, brothers, and sisters) had ever been told by a physician that they had DM. We ascertained DM by self-reporting or a physician's diagnosis of DM and the use of diabetic medication or a blood glycated hemoglobin level ≥6.5%. We excluded any individuals with a previous history of DM from the analysis.

We also asked if they had a history of smoking cigarettes or shisha. Smoking was classified into current, non-smoker or ex-smoker shisha or cigarettes. Shisha smoking – a water pipe – is a way of smoking tobacco, which is sometimes mixed with fruit, through a hose and bowl. The hose ends in a mouthpiece from which the smoker inhales the smoke.

The Berlin questionnaire evaluated whether participants were at risk of obstructive sleep apnea. It is the preferred instrument rather than a STOP-BANG questionnaire, STOP questionnaire or Epworth sleepiness scale. The questionnaire had three categories ssociated with the risk of having sleep apnea. Participants can be classified into high risk or low risk, depending on their responses to each question and their overall scores in the symptom categories. The questionnaire consisted of nine questions that related to snoring and the last question asked whether participants had high BP, did not have it, or did not know if they did. The Berlin Questionnaire was used to assess if sleep apnea was one of the correlates for developing prediabetes. A copy is attached in Appendix 3 along with instructions on the scoring system used in this study to identify participants with a high Berlin score.

Biometric screening exam data was extracted from the electronic medical records at the Dubai Health Authority. This retrieved data was collected as part of the prediabetic screening program at the Dubai Health Authority in 2005 and included FBG, HbA1c, total cholesterol, TG, HDL and LDL cholesterol. Two different cut-offs had been used to define prediabetes: fasting blood glucose of ≥100 mg/dl (≥5.6 and <126 mg/dl) and fasting blood glucose of ≥110 mg/dl (≥6.1 and <126 mg/dl) or an HbA1c level of 5.7-6.4%. Participants were classified as having DM, or being free of DM, based on their HbA1c level of ≥6.5% and fasting blood glucose level of ≥126 mg/dl, and/ or those diagnosed by a physician and/ or on antidiabetic medication. The National Cholesterol Education Programme guidelines that we used define dyslipidemia as follows: HyperTGmia—serum TG levels ≥150 mg/dl and/ or Hypercholesterolemia-serum cholesterol level of <200 mg/dl. The optimal HDL cholesterol level was <100 mg/dl and LDL cholesterol level was <40 mg/dl[40].

3.2.7 Ethical Considerations

3.2.7.1 Ethical Approval of Study

The study protocol was approved by the Human Research Ethics Committee at the Dubai Health Authority, Dubai, the UAE (MRC-05/2014_06, Appendix 2).

3.2.7.2 Informed Consent

Verbal consent was obtained over the phone from all of the subjects before taking part.

3.2.7.3 Confidentiality

The data and questionnaires are stored in the Institute of Public Health at UAE University, where their protection is guaranteed through a password protected file.

3.2.8 Timeline

The baseline data on prediabetes status, based on HbA1c, FBG and plasma lipid levels, was collected within a six month timegrame, from April 2015 to August 2015. Follow-up data, by telephone, was collected within a six month timeframe, from January 2017 to June 2017.

3.2.9 Data Analysis

We entered data into Microsoft Access before it was imported into STATA version 14.0 (StataCorp LP, College Station, TX) for analysis. We summarized categorical variables proportions, and continuous variables using the mean, or median, depending on whichever was most applicable, with 95% confidence intervals. The Chi-square test compared proportion across every group and the ANOVA test compared means across the groups. A descriptive analysis describes the characteristics

of the case data from Dubai. Some of the cases of prediabetes have become DM since the date of the screening and we have completed univariate and multivariate analysis to identify the correlates of prediabetes developing into DM.

Our outcome was to identify how many people with prediabetes have developed DM without following up each patient to see when this transformation actually took place (in term of how many weeks each prediabetic patient took to develop DM) (dominator data was missing). Therefore, we used logistic regression analysis. Furthermore, OR was used in our study to establish the strength of association between the conversion from prediabetes to DM and its correlates.

As our objective was to identify all the variables associated with prediabetes becoming DM, all the variables were included in the analysis. However to account for unstudied variables (residual confounding) we used multivariable analysis. Furthermore, we have checked our data for interactions but could not find any between the variables in our study.

The issue of missing data was only present for the data collected in Dubai. We treated our missing data by referring to a biostatistician who used statistical methods to verify the data. Analysis on the Dubai data was done twice. One analysis was without the missing data and second one was conducted with assumptions made for the missing data. No difference was noted in the results.

3.3 Results

The demographic and clinical characteristics of the study population are presented as a percentage for the categorical variables and as a mean±standard deviation for the continuous variables, in Table 3.1.

Table 3.1: Demographic and clinical characteristics of the study population (n=487) in Dubai, the UAE

Variables	All	Male (n=135)	Female (n=352)
Age (years)	39.6±10.3	37.8±10.0	40.3±10.4
Height (cm)	162.7±8.9	172.2±6.8	159.2±6.8
Weight (kg)	80.4±19.9	87.2±17.6	77.9±20.3
BMI (kg/m^2)	30.5±10.1	29.4±5.7	31±11.2
Total cholesterol (mg/dl)	196.8±38.3	198.2±40.1	196.2±37.5
HbA1c (%)	5.9±0.4	5.9±0.4	5.9±0.4
LDL (mg/dl)	122.6±33.7	126.1±35.9	121±32.5
HDL (mg/dl)	54.2±15.3	47.7±13.2	57.2±15.3
TG (mg/dl)	116.5±63.1	136.1±76.8	107.7±53.6
FBG (mg/dl)	102.4±13.2	102.3±12.7	102.5±13.5
Marital Status			
Single	82 (17.1)	23 (17.6)	59 (17.0)
Married	361 (75.4)	105 (80.2)	256 (73.6)
Widowed or Divorced	36 (7.5)	3 (2.3)	33 (9.5)
Occupation			
Housewife	169 (35.7)	2 (1.6)	167 (48.5)
Healthcare	13 (2.7)	2 (1.6)	11 (3.2)
Army/ Police	24 (5.1)	19 (14.7)	5 (1.5)
Office job	109 (23)	41 (31.8)	68 (19.8)
Business	14 (3)	13 (10.1)	1 (0.3)
Other jobs	144 (30.4)	52 (40.3)	92 (26.7)
Education			
No school	16 (3.4)	2 (1.6)	14 (4.1)
Primary or High school	200 (42.8)	51 (40.2)	149 (43.8)
College or University	251 (53.7)	74 (58.3)	177 (52.1)
PA for at least 30 minutes once a week			
Yes	216 (45.4)	74 (56.5)	142 (41.2)
Consumption of fruits and vegetables			
Everyday	285 (59.3)	71 (53.4)	214 (61.5)
Hypertension (BP ≥140/90)			
Yes	106 (22.1)	32 (24.1)	74 (21.4)
Walk for at least 30 minutes once a week			
Yes	312 (69.3)	89 (71.2)	223 (68.6)
PA (moderate) at least once a week			
Yes	82 (19.7)	35 (31.3)	47 (15.5)
PA (vigorous) at least once a week			
Yes	41 (10)	24 (21.8)	17 (5.7)
Current smoking state			
Yes	46 (9.6)	36 (27.3)	10 (2.9)
Sleep apnea			
Low risk	426 (87.5)	116 (85.9)	310 (88.1)
High risk	61 (12.5)	19 (14.1)	42 (11.9)

3.3.1 Baseline Demographic and Clinical Characteristics of the Study Population

The mean age of the study population was 39.6±10.3 years, ranging from 17 to 60 years. The average age of the male participants was significantly different from the females (37.8 vs. 40.3, *P*=0.017). The percentage of single participants was 17.1%, while 75.4% of the study population were married and 7.5% reported being divorced or widowed. Marital status was found to be significantly different between the males and females (*P*=0.025), as more women were widowed or divorced compared to men (9.5% vs. 2.3%, respectively). Occupation was significantly different between males and females too (*P*<0.001). Being a housewife, or househusband, was more common among females than males (48.5% vs. 1.6%, respectively). Moreover, more males did office jobs when compared to females (31.8% vs. 19.8%, respectively). The participants' level of education varied from no formal education, up to secondary level and above secondary level (3.4%, 42.8%, and 53.7%, respectively). The mean values of height (cm), weight (kg), HDL-cholesterol (mg/dl), and TG (mg/dl) were also significantly different between males and females (P<0.001).

3.3.2 Follow-Up on PA Levels

Figure 11 shows the percentage of participants who reported walking for at least 30 minutes once a week, or were physically active (moderate) at least once a week, or were physically active (vigorous) at least once a week by gender.

The percentage of participants physically active for at least 30 minutes once a week was 45.4%, whereas the percentage of participants who walked for at least 30 minutes once a week was 69.3%. When the participants were asked about practicing moderate PA at least once a week, 19.7% of them answered "yes", whereas only 10%

reported practicing vigorous PA at least once a week. More men stated that they practiced moderate and vigorous PA as compared to women (31.3% vs. 15.5% and 21.8% vs. 5.7%, respectively) (P<0.001).

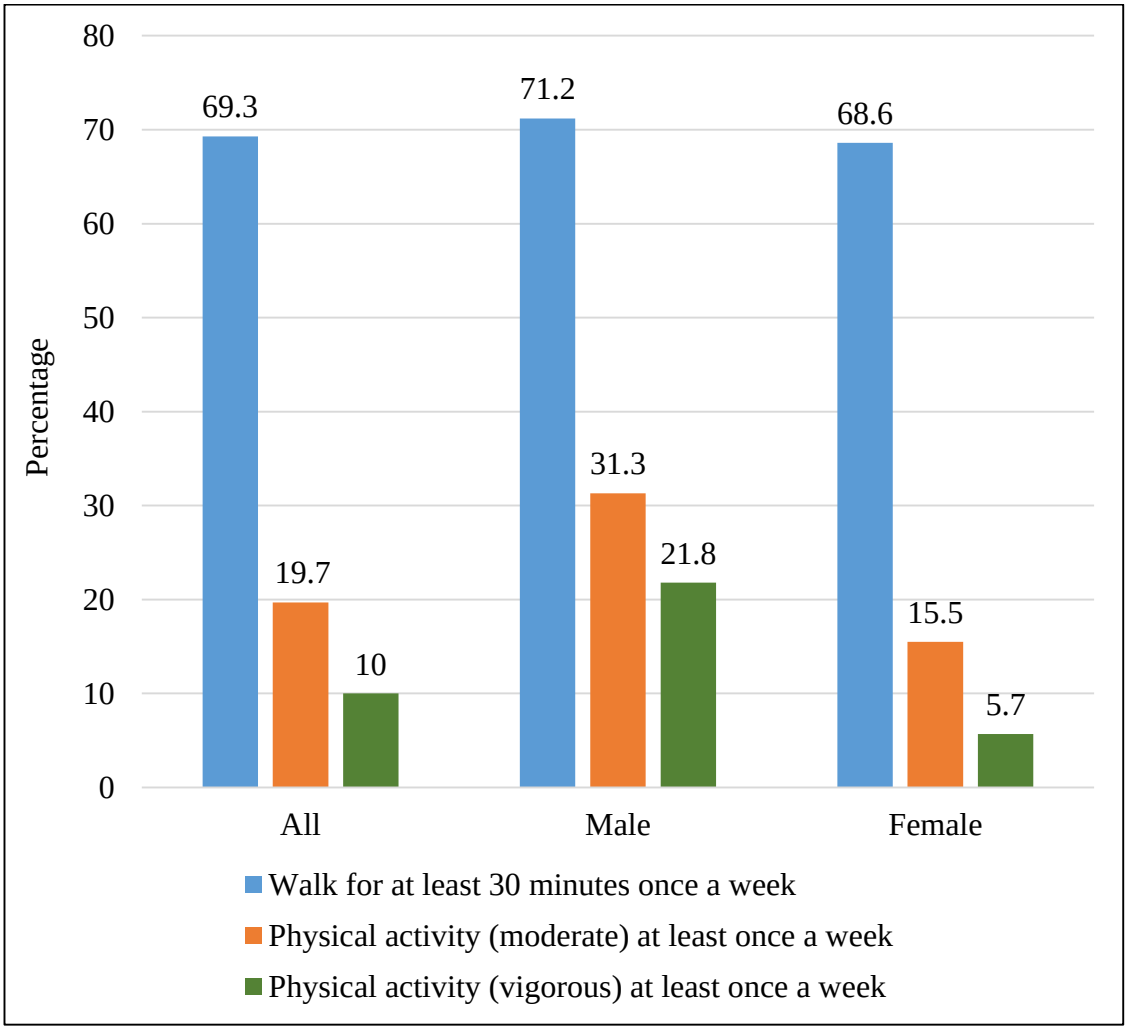

Figure 11: Percentage of participants, by gender, who are PA (n=487) in Dubai, the UAE

3.3.3 Follow-up on Fruit and Vegetable Consumption

Figure 12 shows the percentage of subjects who consume fruit and vegetables on a daily basis compared to those who do not. We have compared by gender.

The percentage who consumed fruit and vegetables on a daily basis was 59.3%. Those who currently smoked cigarettes or shisha was 9.6%. Most of the smokers were men (27.3%) rather than women (2.9%) (P<0.001).

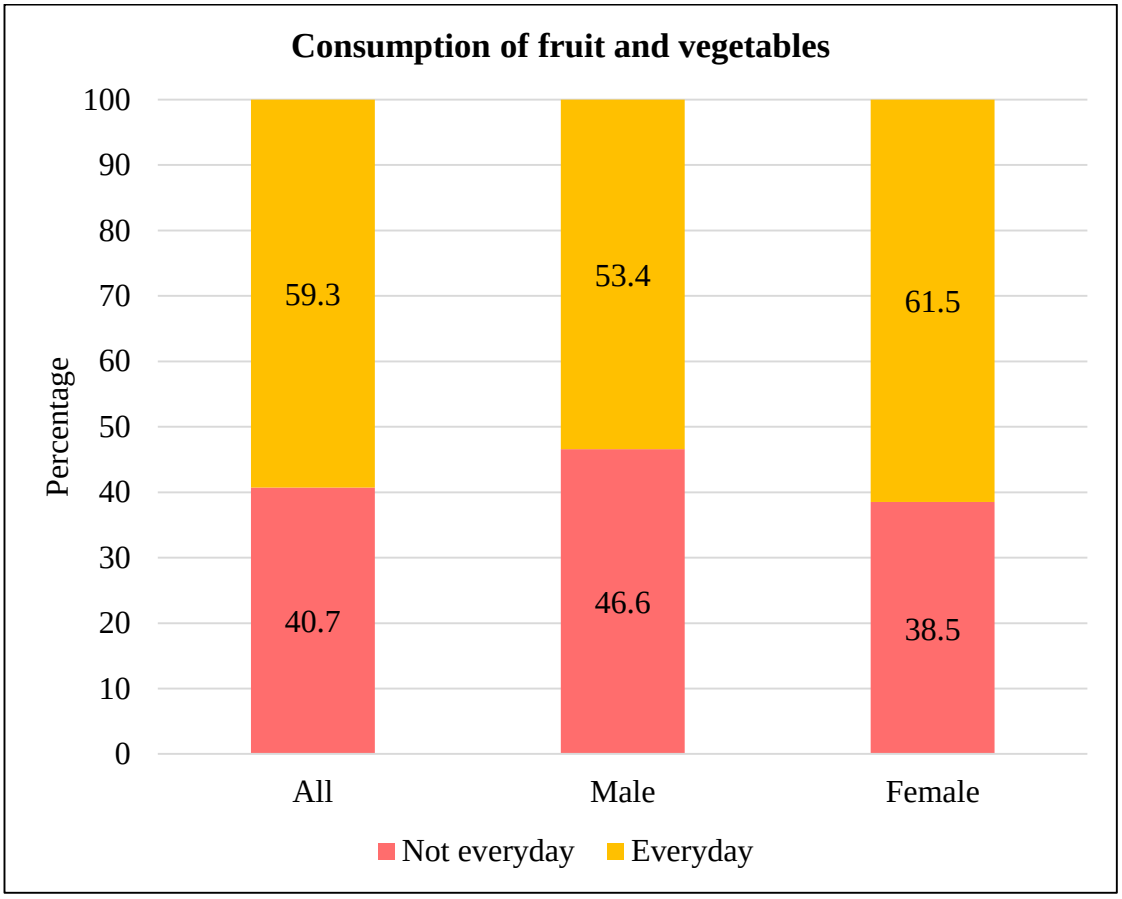

Figure 12: Percentage of participants, by gender, who consume fruit and vegetables on a daily basis (n=487) in Dubai, the UAE

3.3.4 Follow-Up on Sleep Apnea

Figure 13 shows the percentage of participants who appeared to be at high risk of suffering from sleep apnea according to their Berlin Questionnaire answers. Once again, it has been compared across genders. About 12% of females were at high risk of developing sleep apnea as compared to 14.1% of the male subjects. Overall, about 12.5% of our study participants had a high risk of developing sleep apnea when we

administered the Berlin Questionnaire, which identifies respondents as prone to sleep apnea if they record a high Berlin score.

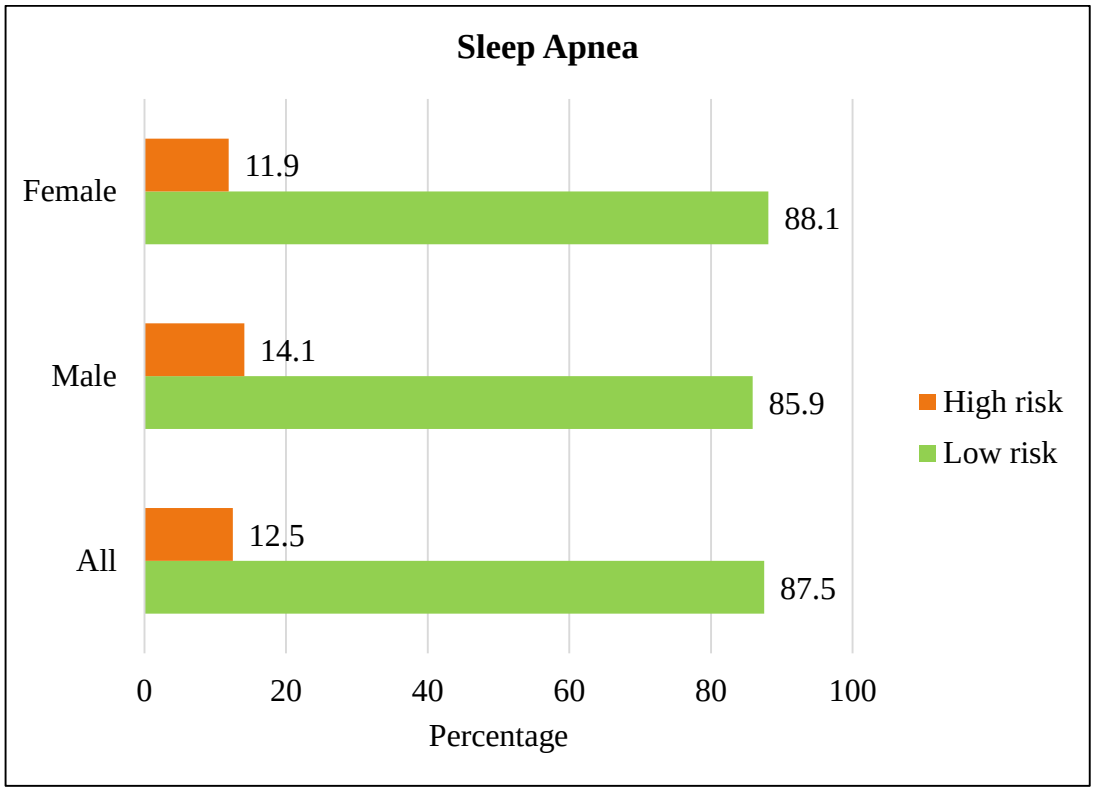

Figure 13: Percentage of participants, by gender, who were found to be at high risk of sleep apnea after using the Berlin Questionnaire (n=487) in Dubai, UAE

3.3.5 Rate of Conversion of Prediabetes to DM

The rate of prediabetic Emirati adult patients developing DM in Dubai was 23.4%, or 114 of our study subjects.

3.3.6 Association between Independent Variables and Conversion from Prediabetes to DM

Regression analysis was used to determine the association between independent variables, such as age, family history, anthropometric measures and biochemical measures, and developing DM from prediabetes. Table 3.2 and Table 3.3

show the univariable and multivariable regression analyses results for the potential for prediabetes to become DM by possible correlates.

Table 3.2: Univariate analyses− unadjusted odds ratios for conversion to DM

Characteristic	All	Converted to DM	
	n	n (%)	OR (95% CI)
Overall Prevalence	487	114 (23.4)	
Age			
17-30 years	100	10 (8.8)	1
31-44 years	165	36 (31.6)	2.51 (1.19, 5.32)
45-60 years	184	68 (59.6)	5.28 (2.57, 10.82)
Gender			
Male	122	32 (28.1)	1.06 (0.66, 1.71)
Female	327	82 (71.9)	1
Marital Status			
Single	75	10 (8.8)	1
Married	337	91 (79.8)	2.40 (1.19,4.88)
Widowed or Divorced	35	13 (11.4)	3.84 (1.48, 9.99)
Education			
No School	15	8 (7.1)	1
Primary or High School	187	54 (47.8)	0.36 (0.12, 1.03)
College or University	236	51 (45.1)	0.24 (0.08, 0.70)
PA for at least 30 minutes once a week			
No	245	66 (58.9)	1
Yes	199	46 (41.1)	0.82 (0.53, 1.26)
Consumption of Fruit and Vegetables			
Not Everyday	185	44 (38.6)	1
Everyday	264	70 (61.4)	1.16 (0.75, 1.79)
Hypertension (BP ≥140/90)			
No	349	72 (63.7)	1
Yes	99	41 (36.3)	2.72 (1.69, 4.38)
Walk for at least 30 minutes once a week			
No	134	36 (32.7)	1
Yes	287	74 (67.3)	0.95 (0.59, 1.51)

Table 3.2: Univariate analyses− unadjusted odds ratios for conversion to DM (Continued)

Characteristic	All	Converted to DM	
	n	n (%)	OR (95% CI)
PA (moderate) at least once a week			
No	310	82 (84.5)	1
Yes	79	15 (15.5)	0.65 (0.35, 1.21)
PA (vigorous) at least once a week			
No	342	92 (96.8)	1
Yes	39	3 (3.2)	0.23 (0.07, 0.75)
Current Smoking State			
No	406	100 (87.7)	1
Yes	41	14 (12.3)	1.59 (0.80, 3.14)
Sleep Apnea			
Low risk	393	96 (84.2)	1
High risk	56	18 (15.8)	1.47 (0.80, 2.69)
BMI Categories			
<25	72	14 (16.9)	1
25.0-29.9	109	22 (26.5)	1.05 (0.50, 2.21)
≥30.0	147	47 56.6)	1.95 (0.99, 3.84)
Total Cholesterol Levels (mg/dl)			
<200	184	55 (63.2)	1
≥200	165	32 (36.8)	0.56 (0.34, 0.93)
LDL-Cholesterol Levels(mg/dl)			
<130	203	62 (71.3)	1
≥130	146	25 (28.7)	0.47 (0.28, 0.79)
HDL-Cholesterol Levels (mg/dl)			
Normal	274	59 (67.8)	1
Low (<40 in male <50 in female)	75	28 (32.2)	2.17 (1.25, 3.76)
TGs Levels (mg/dl)			
Normal	268	62 (71.3)	1
High (≥150)	81	25 (28.7)	1.48 (0.86, 2.57)

By using multivariable analysis we were able to select variables that were shown be significant in the univariable analysis. These were: age, marital status, level of education, hypertension, practicing vigorous PA at least once a week, total cholesterol levels, LDL-cholesterol levels, and HDL-cholesterol levels.

Table 3.3: Multivariable logistic regression analysis− adjusted odds ratios (AORs) for conversion to DM

Characteristic	Converted to DM Adjusted ORs (95% CI)
Age	
18-30 Years	1
31-44 Years	0.95 (0.34, 2.62)
45-60 Years	2.33 (0.84, 6.44)
Marital Status	
Single	1
Married	1.28 (0.513, 3.19)
Widowed or Divorced	1.46 (0.37, 5.85)
Education	
No School	1
Primary or High School	0.44 (0.11, 1.80)
College or University	0.43 (0.11, 1.78)
Hypertension (BP ≥140/90)	
No	1
Yes	1.70 (0.85, 3.39)
PA (vigorous) at least once a week	
No	1
Yes	0.28 (0.08, 0.99)
Total Cholesterol Levels (mg/dl)	
<200	1
≥200	1.18 (0.45, 3.06)
LDL-Cholesterol Levels(mg/dl)	
<130	1
≥130	0.41 (0.15, 1.11)
HDL-Cholesterol Levels (mg/dl)	
Normal	1
Low (<40 in male <50 in female)	3.45 (1.74, 6.85)

3.3.7 Association between DM and Age

Univariable Analyses

In the univariable analyses, older participants (45-60 years) were 5.2 times more likely to develop DM ([OR] =5.2; 95% CI 2.57 to 10.82) as younger participants (18-30 years).

Multivariable Analyses

The relationship between DM and age was not significant in these multivariable analyses.

3.3.8 Association between DM and Marital Status

Univariable Analyses

Widowed or divorced participants were 3.8 times more likely to develop DM ([OR] =3.8; 95% CI 1.4 to 9.9) as single participants (*P*=0.006), and married participants were 2.4 times more at risk of becoming diabetic ([OR]=2.4; 95% CI 1.1 to 4.8) when compared to single participants (*P*=0.015).

Multivariable Analyses

The correlation between DM and marital status was not significant in these multivariable analyses.

3.3.9 Association between DM and Educational Level

Univariable Analyses

Participants who reported an education at college or university level (n=236) had a 0.24 times higher risk of becoming diabetic (OR=0.24; 95% CI 0.08 to 0.70) when compared to participants without a formal education (n=15) in these univariable analyses (*P*=0.009).

Multivariable Analyses

The association of DM and educational level was not significant in the adjusted analyses.

3.3.10 Association between DM and Physical Activity

Univariable Analyses

Practicing vigorous PA at least once a week was significantly associated with a 0.23 risk of DM (P<0.015) in the univariable analyses, when compared to those who did not do vigorous PA at least once a week (OR=0.23; 95% CI 0.07 to 0.75).

Multivariable Analyses

The association between DM and PA remained significant in the adjusted analyses (aOR=0.28; 95% CI 0.08 to 0.99; P=0.047).

3.3.11 Association between DM and Hypertension

Univariable Analyses

Participants who reported having hypertension (n=99) had a 2.7 times higher risk of DM (OR=2.72; 95% CI 1.69 to 4.38) as compared to participants with normal BP(n=349) in these univariable analyses.

Multivariable Analyses

The relation between DM and hypertension was no longer found to be significant after adjustment was made for confounding factors.

3.3.12 Association between DM and Cholesterol and HDL-Cholesterol Levels

Univariable Analyses

Elevated total cholesterol levels (≥200 mg/dl) showed a significant relationship to the conversion of prediabetes to DM (OR=0.56; 95% CI 0.34 to 0.93; P<0.001) in

univariable analyses. Participants who had low HDL-cholesterol levels (<40 mg/dl male <50 mg/dl female) (n=75) had a 2.1 times higher risk of developing DM (OR=2.17; 95% CI 1.25 to 3.76, *P*=0.006) when compared to participants with normal HDL-cholesterol levels (n=274) in the univariable analyses.

Multivariable Analyses

There was no significant association between DM and cholesterol after adjusting for confounding factors. However, the association between DM and HDL-cholesterol levels remained significant in the adjusted analyses (aOR=3.45; 95% CI 1.74 to 6.85; *P*<0.001).

3.3.13 Association between DM and Other Associates

The univariable analyses did not show any significant association between developing DM and any of the following variables: these were gender; being physically active for at least 30 minutes once a week; walking for at least 30 minutes once a week; practicing moderate PA at least once a week; daily consumption of fruit and vegetables; smoking; being at high risk of sleep apnea; BMI categories and TGs levels.

3.4 Discussion

In the retrospective follow-up study, we measured the correlates that lead to prediabetes becoming DM and quantified the effect of these correlates on individual characteristics. Although there is a widespread consensus that prediabetes is a risk factor in developing DM[20,32,45] and the correlates for DM in people with prediabetes differ from those with normal glucose tolerance[165] there are, to our knowledge, no studies available that deal with this development (from prediabetes to DM) in the UAE.

The majority of studies on the risk factors and correlates for NCD that have been conducted in the UAE were done so in an educational setting (schools and universities). Very few have been done outside of such settings and our study sought to redress this imbalace. This study, which involved 487 prediabetic participants showed that 37% of men and 21% of women practice moderate to vigorous PA. The percentage of PA for women was much lower than the figures reported in previous studies by Shu Wen (41%)[121] but is consistent with the other studies[120] showing that men were more active than women in the UAE. In several previous studies, it was reported that the consumption of fruit and vegetables is low in the UAE[136]. In our study 59% of the participants consumed fruit and vegetables on a daily basis.

Our findings show that age, marital status, education level, PA, hypertension, elevated total cholesterol level and low HDL cholesterol level were associated with the conversion of prediabetes into DM for our study population. There are several studies extant in the UAE dealing with the risk factors for developing DM in the UAE but fewer studies on prediabetes. However, to the best of our knowledge, there is no other study, in a UAE context, that examines the correlates for prediabetes developing into DM in the national population.

3.4.1 Rate of Conversion of Prediabetes to DM

Prediabetes is a high-risk disorder that can develop into DM[11]. Type one diabetes is not associated with prediabetes as it has a different pathogenesis[27]. Between 5% and 10% of people with prediabetes develop DM each year[164]. In most of the populations studied, 60% of people who develop DM have either IGT or IFG for five years or so before the onset of the disease[27]. The rate of conversion from IFG and IGT to DM is similar, with IGT having greater sensitivity but less specificity when

compared to IFG in terms of predicting conversion to DM. The positive predictive value for IGT and IFG to develop into DM is the same[45].

The development of prediabetes into DM happens in stages[3]. The first phase is the compensatory stage where insulin resistance is present, in addition to an increase in insulin secretion and beta cell mass. Stable adaptation is the second stage where beta cells no longer fully compensate for increased insulin resistance. At this stage, the insulin level decreases but the fasting and postprandial glucose levels are still normal. The first and second stages occur before the prediabetic stage has been reached. During the third stage of developing DM, the period from prediabetes to DM, beta cells lose their compensatory mechanism for insulin resistance. Thus, glucose levels increase quickly[3].

In our study, the rate of conversion of prediabetes patients to DM in Emirati adults in Dubai was observed in 114 (23.4%) of our participants. The first FPG was taken in 2015 as part of a DHA screening process in primary healthcare centers in Dubai. Then in 2017, a 1,000 sample frame (prediabetic patients) was taken from the date above and another FPG was measured with the same patients. The rate of conversion from prediabetes to DM in a two-year period was 23.4%. This is equivalent to a yearly conversion rate of around 12%. This rate was higher than was reported in another study, where the rate was between 5% and 10% of people with prediabetes developing DM each year[164].

Adults in the USA with normal glucose levels have a 0.7% average yearly risk of developing DM[165]. The ADA expert panel has predicted that up to 70% of individuals with prediabetes will eventually develop DM[165]. This conversion varies, according to the definition of prediabetes and population characteristics. In a Chinese

diabetes prevention trial, the 20-year cumulative incidence of DM was >90% when using IGT defined with repeated OGTTs[66]. In India, a 10-year follow-up to the Chennai Urban Rural Epidemiology Study showed that 58.9% of people with prediabetes developed DM. Those patients had a considerably greater level of FBG, two-hour postprandial, and HBA1c, and were more likely to have a family history of DM. They were also less likely to consume alcohol[168]. On the other hand, several trials have proven that people with prediabetes can become normoglyceamic after lifestyle and drug-based interventions[81]. In England, for example, 55%-80% of people with IFG had a normal FBG after 10 years. However, other trials reported a lower conversion rate[11].

In summary, people with prediabetes face three different scenarios: around a third of cases will develop DM, another third will remain prediabetic and the remaining third can revert to normoglycemia status[6]. Studies show that the risk of developing DM can be reduced by 58% if people exercise moderately for 30 minutes a day, five days a week and lose 7% of their total body weight[1].

3.4.2 Percentage of Smokers in our Study Population

The percentage of smokers (cigarettes or shisha) in our sample was 9.6%. Most smokers were men (27.3%) as compared to women (2.9%). This figure is similar to the one reported in a review of an approach to chronic diseases in Abu Dhabi by Hajat et al. (9%), but is lower than the figure reported in the Weqaya screening program (11%). It is significantly lower than the 2007 rates in the USA (20%) and the UK (22%)[41]. The reasons for these findings are beyond the scope of this study.

3.4.3 Percentage of People with Sleep Apnea in our Study

The current study used the Berlin questionnaire on sleep apnea a determinant of sleep apnea syndrome in prediabetic patients. About 12.5% of sparticipants were found to be at high risk of obstructive sleep apnea. This figure is much lower than the one previously reported in the UAE (20.9%)[169], Saudi Arabia (33.3%), Jordan (16.8%)[170] and Spain (26.7%)[171].

3.4.4 Physical Activity as a Correlate of Conversion from Prediabetes to DM

Physical inactivity was one of the correlates in our study. Practicing vigorous PA at least once a week was significantly associated with a 77% reduction in the conversion of prediabetes to DM, when compared with those who do not do vigorous PA at least once a week. This finding is consistent with findings in several other studies[168], including the Strong Heart Study[165] where physical inactivity was reported as being an independent correlate for the conversion of prediabetes to DM.

3.4.5 Lipid Profile as a Correlate of Conversion from Prediabetes to DM

Elevated total cholesterol levels and a low level of HDL were another correlate for conversion of prediabetes to DM in our study. Participants who reported having elevated total cholesterol levels (≥200 mg/dl) and low HDL-cholesterol levels (<40 mg/dl male <50 mg/dl female) had 44% more chance, and were 2.17 times more at risk, of developing DM, when compared to participants with normal total cholesterol and HDL-cholesterol levels in our univariable analyses. This finding has been confirmed in other studies[165,168,173]. While an elevated total cholesterol level was found to be no longer significant after adjusting for confounding factors such as age, low HDL-cholesterol levels remained significant in the adjusted analyses (aOR=3.45). In

spite of this, the HDL-level was not related significantly to the incidence of DM in the Strong Heart Study[165].

3.4.6 Age as a Correlate of Conversion from Prediabetes to DM

Our analysis showed that age is a significant correlate for DM in those with prediabetes (univariable analyses). Older participants (45-60 years) were 5.28 times more likely to develop DM than younger participants (18-30 years). This finding is consistent with the results found in several other studies[168,172], including the Strong Heart Study[165] and a retrospective cohort study, which studied 5,452 prediabetic subjects in the United States. This study confirmed that the prevalence of DM increases markedly with age in people with prediabetes. Furthermore, the younger the person is at the time of the diagnosis of prediabetes, the more likely they are to develop DM. This could be due to the fact that the development of hyperglycemia at a younger age means there is a greater degree of insulin resistance and a decline in beta cell function, leading to a fast rise in glucose levels. It is also possible this is due to an increase in the rate of identifying DM at this younger age as clinicians do more frequent screening for high glucose levels[173]. However, in our study, the effect of age on the conversion to DM was not significant in the multivariable analyses, but it was in the Strong Heart Study after adjusting for covariates[165].

Our research has explored the correlates for DM developing in prediabetic patients. These included age, marital status, education level, PA, hypertension, elevated total cholesterol and low HDL cholesterol level. The significance of the associations differed among the correlates. Some of the correlates showed a stronger significance (age, marital status, the presence of hypertension, low HDL-cholesterol levels) compared to others (PA level, educational status, elevated total cholesterol

levels). Furthermore, some of the correlates that showed significant association in the univariable analyses did not remain significant after adjusting for other potential confounding factors such as hypertension, elevated total cholesterol levels, etc. in the multivariable analyses. These were age, marital status, education level, HT. Low HDL-cholesterol levels and physical activity levels were the only correlates that showed significance in the univariable analysis and remained the same in the adjusted multivariable analyses. Furthermore, many variables in our study, such as smoking, gender, BMI and sleep apnea, were commonly reported as being independent risks for the conversion of prediabetes into DM in previous studies[164,165,172,173,177,178] but did not show as significant in our study. We reflected that the biological difference between the baseline and outcome cohort was not great enough for minor variables to be recognized as independent and significant correlates. Of course, differences in the entry and outcome standards of our study and previous studies might also account for differences in the significance outlines.

3.5 Strengths of Our Study

To our knowledge, this is the first study in Dubai, the UAE, to explore the rate of conversion of prediabetes to DM and its correlates and associations. Furthermore, the recruitment of subjects followed strict inclusion criteria to ensure control of selection bias. Measurement bias was overcome by collecting with well-trained staff from five healthcare centers in Dubai. Furthermore, an adequate sample size was used and our study adjusted for many correlates.

3.6 Limitations of our Study

There are some potential limitations of our study that need to be considered. For example, the primary limitation is the inability to find out the exact date of conversion from prediabetes to DM as we did not follow-up individual participants and could not calculate person-time to use as denominator. Furthermore, every variable included in our analysis was self-reported, and thus dependent upon the participants' memory. This might have led to inaccurate data, especially in relation to family history. However, the self-report format does have the advantages of convenience, simplicity and low costs, and may be more uniform in its presentation than face-to-face screening. In addition, the Berlin Questionnaire was used to assess sleep apnea. This questionnaire has a very low specificity. Furthermore, we could not independently approve or refute reports of snoring or daytime sleepiness by the respondents.

Furthermore, the ADA recommends a repeat measurement after a single HA1c, FPG, or 2-hour PG diabetes-positive test result, which we could not do because most participants had only one blood test. Therefore, some participants without DM may have been misclassified as having DM in our study and it is unclear how frequently this has occurred.

Design effect is important in any cross-sectional study. With probability proportional to size, where samples from different sized subgroups are used and sampling is taken with the same probability, the chances of selecting a member from a large group are less than selecting a member from a smaller group. This takes varying sample sizes into account, but was not taken into account when choosing our target population. Therefore our data may be under-representative of the general population

of the UAE. We feel that not considering probability proportional to size in our design is one of our study's limitation. Moreover, the participants were not all UAE nationals, so the findings cannot be generalized to groups with different ethnic backgrounds even if living in the UAE.

Chapter 4: Conclusion

4.1 Overall Summary

This descriptive study is intended to measure the prevalence, characteristics and correlates of prediabetes in the adult population of the UAE. It is vital to identify prediabetes in any population as it increases awareness levels in the community and also helps in the design of appropriate educational programs to modify the correlates for prediabetes and can lead to the prevention or delay in progression of prediabetes to DM. Therefore, the information collected in this study will help both decision makers and policy makers in many ways. Additionally, the analysis in this study provided useful information about the prevalence of prediabetes, DM and obesity in the UAE. It also explored the correlates of prediabetes and DM, and factors that can lead to the conversion of prediabetes into DM.

The prevalence of prediabetes in this study (37.7%) was much higher than reported in a population-wide cardiovascular screening program (Weqaya) in Abu Dhabi in 2012, where prediabetes was only 27%[40]. This increase is consistent with the increasing incidence of prediabetes in GCC[38,39], Asian[33,37,152], European[32] and North American[23,31] countries. Furthermore, the prevalence of prediabetes increases with age, with the highest incidence in people aged 34-54 years. Increased body mass index was another correlate for developing prediabetes, particularly if in the obese BMI range. Prediabetes was also significantly associated with educational level.

The overall prevalence of DM in our study was 18.7%, which was similar to the one reported in a population-wide cardiovascular screening program (Weqaya)[40] in Abu Dhabi. We found that older age (≥55 years), obesity, lack of PA, education

level, high WHR, having a family history of DM and TGs level were statistically significant correlates for DM in our study.

The prevalence of obesity in the UAE was shown to be rising and was significantly associated with prediabetes and DM. Furthermore, being overweight (BMI between 25.0 and 29.9 kg/m^2) and obesity (MBI ≥30 kg/m^2) were detected in 35.7% and 50.1% of the study population, respectively. This figure is alarming as it is higher than the one reported in the Weqaya study in 2012 (35%) and a population-based cross-sectional study in 2000, also in the UAE (34%)[40].

Our findings show a lack of vigorous PA to be a significant correlate of DM and prediabetes, and practicing vigorous PA at least once a week reduced the conversion rate of prediabetes to DM by 77%. Furthermore, many variables in our study, such as age, hypertension, smoking, gender, BMI and sleep apnea, have been commonly reported in previous studies as independent risks for the conversion of prediabetes to DM. However, they did not show any significance in our study. It is likely this is due to the sample size of our study, which could somewhat clarify the inconsistent results. Furthermore, having a healthy diet and good weight management via PA and controlling lipid profiles will help to reduce the prevalence of prediabetes and the conversion of prediabetes to DM.

The UAE's health care system is facing difficult challenges as prediabetes, DM and obesity are all becoming more prevalent and putting a strain on the UAE's human and financial resources. Unless policies, laws and the healthcare system are modified, the advances in healthcare that have been accomplished over the past forty years will be eroded.

In addition, there needs to be future intervention studies in order to explore the correlates for prediabetes and the conversion of prediabetes into DM in a larger, more diverse non-local population in the UAE. The relationship between sleep apnea and prediabetes also requires additional examination. Future studies must be conducted, and repeated, in different Emirates to determine if the findings continue to be consistent with the results of our study.

4.2 Recommendations

The UAE's epidemic of obesity requires urgent and aggressive intervention. This is necessary to prevent chronic diseases from damaging the accomplishments of the UAE government over the last 40 years in improving the overall health of UAE nationals. In order to achieve this, polices and laws must be formulated and efforts united. Lifestyle management plays a major role in combating obesity, prediabetes and DM at an individual level. Both policy makers and decision makers have an important role in this battle.

As the prevalence of prediabetes is high in the Emirati population, educating people about prediabetes, its correlates and the measures required to return to a normal state, is vital. It is also crucial to recognize prediabetes as a disease that leads to several complications, including DM. Moreover, early detection of prediabetes and implementing preventative measures to stop its progression to DM is essential. Other important recommendations include:

- Collective efforts are needed to reduce the prevalence of prediabetes and DM to empower the public to take care of their own health. This can be done through education. This education should concentrate on the dangers of an

unhealthy lifestyle and behaviors (PA and an unhealthy diet) and can be delivered via the media and social media channels. Furthermore, educational programs (which target the correlates for chronic diseases like DM and hypertension) are required to target people in schools and the community. Increasing levels of health education amongst the public will encourage people to make healthier selections.

- It is essential to strengthen the role of primary healthcare centers. This can be achieved by applying preventative strategies in primary healthcare that can detect who is at high risk of prediabetes and obesity. This will ensure the early detection of prediabetes and interventions that can lead to a delay in the progression of prediabetes to DM. An individualized wellness program could be established, which must include diet counselling and exercise plans to address the correlates for chronic diseases, like obesity, as well as a lack of PA and unhealthy eating habits. These programs will increase people's awareness of the risks.
- Public health policies at a national level need to be implemented in the UAE. These polices have to focus on improving public health by creating a healthy community that replaces the "obesogenic" environment and encourages healthy lifestyle behaviors. This should concentrate on limiting the spread of fast food outlets, making healthy food both easily affordable and accessible, and imposing taxes on tobacco, foods high in fat and sweet drinks. It is also important to create an encouraging environment for exercise and PA for both genders and all ages.

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List of Publications

- Shah S, Loney T, Sheek-Hussein M, El Sadig M, Al Dhaheri S, El Barazi I, Al Marzouqi L, Aw T, Ali R (2015) Hypertension prevalence, awareness, treatment, and control, in male South Asian immigrants in the United Arab Emirates: a cross-sectional study. BMC Cardiovascular Disorders 7;15:30.

Appendices

Appendix 1: Ethics Approval from Al Ain Medical District Human Research

UAEU Faculty of Medicine and Health Sciences

جامعة الإمارات العربية المتحدة
United Arab Emirates University

24 March 2013

Dr. Syed M. Shah
Associate Professor
Institute of Public Health
CMHS – UAE University
Al Ain - UAE.

Dear Dr. Syed Shah:

Re: Al Ain Medical District Human Research Ethics Committee - Protocol No. 13/09 – Prevention of Type 2 Diabetes through community based strategies: A randomized control trial.

Thank you very much for submitting the above application to the committee.

Your submitted documents were reviewed by the committee and I am pleased to provide you ethical approval of your project.

May I reiterate, should there be any ethical concern arising from the study in due course the committee should be informed.

Annual reports plus a terminal report are necessary and the Committee would appreciate receiving copies of abstracts and publications should they arise.

I wish to take this opportunity to wish you success with this important study.

This Ethics Committee is an approved organization of Federal Wide Assurance (FWA) and compliant with ICH/GCP standards.

With kind regards,

Yours sincerely,

Fawaz Chith Tor

Dr. Fawaz Torab
Chair, Al Ain Medical District Human Research Ethics Committee
/S[3]

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Appendix 2: Ethics Approval from Dubai Health Authority

GOVERNMENT OF DUBAI

MEDICAL RESEARCH COMMITTEE
APPROVAL LETTER

DUBAI HEALTH AUTHORITY

From :	Dr. Azan Salem BinBrek Chairman-Medical Research Committee Dubai Health Authority	**Date :**	08 Jun 2014
To :	Dr. Syed M Shah Associate Professor College of Medicine and Health Science, Institute of Public Health, United Arab Emirates University	**Ref :**	MRC-05/2014_06

Subject: Approval for the research proposal: **"Prevention of Type 2 Diabetes through Community Base Strategies: A Randomized Controlled Trial"**

Short Title: **Type 2 Diabetes prevention through population based strategies."**

Dear Dr. Syed M Shah,

Thank you for submitting the above mentioned research proposal to the Medical Research Committee, DHA. The Medical Research Committee has been organized and operates in accordance with the ICH/GCP guidelines.

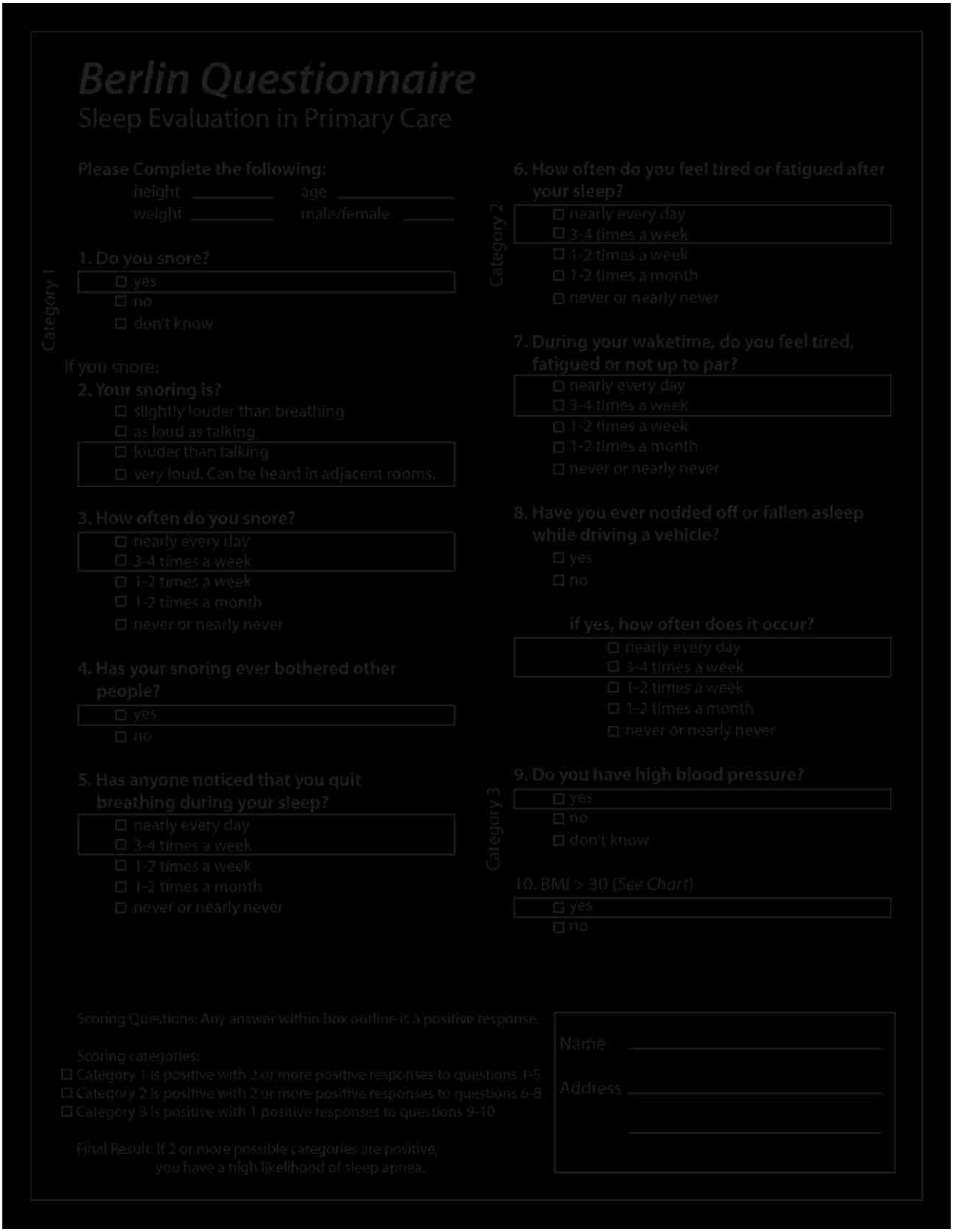
Your request was discussed during the Medical Research Committee meeting held on 04th Jun 2014. I am pleased to advice you that the committee has granted ethical approval for the above mentioned study.

Please note that it is the MRC's policy that the principal investigator should report to the committee of the following:

1. Anything which might warrant review of ethical approval of the project in the specified format, including:
   - any serious or unexpected adverse events and
   - unforeseen events that might affect continued ethical acceptability of the project
2. Any proposed changes to the research protocol or to the conduct of research
3. Any new information that may affect adversely the safety of the subjects
4. If the project is discontinued before the expected date of completion (reason to be specified)
5. Annual report to the MRC about the progress of the study
6. A final report of the finding on completion of the study

Please note that this approval is valid for **one year** from the date of this letter. It is your responsibility to ensure that an application for continuing review approval has been submitted at the required time.

Appendix 3: Berlin Questionnaire



Berlin Questionnaire

Sleep Evaluation in Primary Care

Please Complete the following:

height _____ age _____

weight _____ male/female _____

Category 1

1. Do you snore?

- ☐ yes
- ☐ no
- ☐ don't know

If you snore:

2. Your snoring is?

- ☐ slightly louder than breathing
- ☐ as loud as talking
- ☐ louder than talking
- ☐ very loud. Can be heard in adjacent rooms.

3. How often do you snore?

- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

4. Has your snoring ever bothered other people?

- ☐ yes
- ☐ no

5. Has anyone noticed that you quit breathing during your sleep?

- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

Category 2

6. How often do you feel tired or fatigued after your sleep?

- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

7. During your waketime, do you feel tired, fatigued or not up to par?

- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

8. Have you ever nodded off or fallen asleep while driving a vehicle?

- ☐ yes
- ☐ no

if yes, how often does it occur?

- ☐ nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ never or nearly never

Category 3

9. Do you have high blood pressure?

- ☐ yes
- ☐ no
- ☐ don't know

10. BMI > 30 *(See Chart)*

- ☐ yes
- ☐ no

Scoring Questions: Any answer within box outline is a positive response.

Scoring categories:

☐ Category 1 is positive with 2 or more positive responses to questions 1-5

☐ Category 2 is positive with 2 or more positive responses to questions 6-8

☐ Category 3 is positive with 1 positive responses to questions 9-10

Final Result: If 2 or more possible categories are positive, you have a high likelihood of sleep apnea.

Name _____

Address _____

_____

Appendix 4: Global Health-Developed Developing Countries Partnership for Non-Communicable Disease Prevention

Researcher Name		Coordinator Name	
Date of interview		Time of Interview	
Student Name		Student No.	
Class			
Name of School			
Respondent's Name:			
1-	Respondent's Gender: 1. Male 2. Female		
2-	Nationality	UAE	Others……..
3-	Age in years …… DOB …../…../……..		

Section A			
General Information			
5-	What is the highest class/level of education that completed?	Illiterates Primary Middle Secondary Diploma, Graduate, Masters/MBA,PHD	1 2 3 4 5
6-	What is your marital status?	Married Divorced Widowed Do not know Refused	1 2 3 77 99
7-	Are you blood related to your spouse?	Yes No	1 2
8-	IF YES-What's the relationship with your spouse?	First cousin[1] Second cousin[2] Other: _____	1 2
9-	How many children do you have?	Boys_____ Girls _____	
10-	In which type of family system do you live? *1. Husband, wife, parents, in-laws and other* *2. Only husband, wife and children*	Joint family system[1] Nuclear[2]	1 2
11-	What is your Mother Language?	_____	
12-	Are you currently employed or engaged in any business?	Yes No	
	If Yes		
13-	What Nature of your work/employment? …….	←___	
14-	How Many Years in the current work?		
15-	…… Monthly salary/income? ……..Dh		
	If Not		
16-	Reason for not being employed? 2 ***(Multiple responses possible)***	Student Housewife Retired Jobless Other Specify _____	1 2 3 4 5
17-	Do you own the house you live in?	Yes No	
18-	How many people live in the house? …….		

SECTION B			
In this section I would like to ask you about your health			
B1	What would you say about your health in general?	Excellent	1
		Very Good	2
		Good	3
		Fair	4
		Poor	5
B2	How much you are satisfied with your life?	Very happy	1
		Happy	2
		Fair	3
		Not happy	4
		Very unhappy	5
B3	Before this interview, Had your BPever been checked?	Yes	1
		No	2
B4	Has a health care provider ever told you that you have high BPalso called hypertension? **If not-Move to Question B10**	Yes	1
		← No	2
B5	What was your age when you were told that you have high BP?	_____ years	
B6	Because of your high BPhave you were ever being told by a health care provider to take prescribed medicine?	Yes	1
		No	2
B7	Are you currently (since last month) taking any medicine for BP?	Yes	1
		No	2

B8	Please, mention the names and dosages of medicines you are using. If you do not know the names of medicines then kindly show me these medicines.			
No.	**Name of Medicines**	**Type** 1. Tablets, 2. Capsules, 3. Syp/Susp, 4. Injection, 5. Inhalers, 6. Others	**Dosage**	**per day**
01				
02				
03				
04				
05				

B9	Have you taken your BPmedicine today or during the last 2 days? If not, what was the reason for not taking the BPmedicine?	Yes today Yes in last two days No _____ __ _____	1 2 3
B10	Did any of your first degree relatives (mother, father, brother, sister, son, daughter) were told by a doctor or other health professional that they had high BP?	Yes No Don't know	1 2 3
Heart Disease			
B11	Has a doctor or other health professional ever told you that you have Heart Disease? **If Not-Move to Question B16**	Yes ← No	1 2
B12	What was that heart disease?	Angina Heart Attack Other (specify)_____	1 2 3
B13	How old were you when you were told?	_____years	
B14	Were you prescribed treatment for it?	Yes	1
	If Not-Move to Question B16	← No	2
B15	If yes, the type of treatment was?	Medical treatment only Medical & surgical treatment Other (specify) _____	1 2 3
B16	Did any of your first degree relatives (mother, father, brother, sister, son, daughter) were told by a doctor or other health professional that they had a heart attack before the age of 55 years??	Yes ← No ← Don't Know	1 2 3
Cholesterol and TG			
B17	Have you ever had your blood lipids measured (Cholesterol or TGs)?	Yes No	1 2
B18	Have you ever been told by a doctor, or another health professional that your blood cholesterol level was high? **If Not-Move to Question B20**	Yes ← No	1 2
B19	Are you currently taking any treatment for your high cholesterol?	Yes No	1 2

Kidney Disease			
B20	Has a doctor or other health professional ever told you that you have a kidney disease?	Yes ← No	1 2
B21	If yes, what kind of kidney disease you had?	_____ _____	
Diabetes			
B22	Has a health care provider ever told you that you have Diabetes?	Yes ← No	1 2
	If Not-Move to Question B20		
B23	How was your diabetes diagnosed?	Had symptoms	1
B24	***(More than one responses possible)***	Screening test (high blood sugar) Sugar in Urine Others (specify)_____	2 3 4
B25	Were you prescribed any treatment or restricted diet for your diabetes?	Yes No	1 2
B26	**If yes**, Type of current treatment you are taking for diabetes? ***(More than one responses possible)***	Insulin injections Tablets Restricted Diet Others (specify)_____	1 2 3 4
B27	Have you taken your diabetes medicine today or during the last 2 days?	Yes, today Yes, in the last 2 days No, I did not take any medication Why?_____ _____ _____ _____	1 2 3
B28	Do you have a blood sugar checking device at your home?	Yes No Don't Know	1 2 3
B29	Did any of your first degree relatives (mother, father, brother, sister, son, daughter) were told by a doctor or other health professional that they had diabetes?	Yes ← No ← Don't Know	1 2 3

Stroke			
B30	Has a doctor or other health professional ever told you that you had a stroke?	Yes No Don't know	1 2 3
B31	Do you know the cause of stroke?	Yes No	1 2
B32	If Yes, what is the major cause? Specify:	_____	
B33	Did any of your first degree relatives (mother, father, brother, sister, son, daughter) were told by a doctor or other health professional that they had a stroke?	Yes No	1 2
Injury			
B34	Did you get an injury in the past 12 month that needed treatment?	Yes	1

SECTION C

International Physical Activity Questionnaire (IPAQ) Short-version

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Vigorous

Think about all the **vigorous** activities that you did in the **last 7 days**. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

C1	During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics or fast bicycling**?**	None	1
		1 Day	2
		2 Day	3
		3 Day	4
		4 Day	5
		5 Day	6
		6 Day	7
		7 Day	8
		Don't Know	77
		Refuse	99
	If None, Don't Know, Refuse **Skip to Q. C3**		
C2	How much time did you usually spend doing **vigorous** physical activities on one of those days?	_____ hours/day _____ minutes/day	

Moderate

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

C3	During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? <u>Do not include walking</u>.	None	1
		1 Day	2
		2 Day	3
		3 Day	4
		4 Day	5
		5 Day	6
		6 Day	7
		7 Day	8
		Don't Know	77
		Refuse	99
			9
	If None, Don't Know, Refuse **Skip to Q. C5**		
C4	How much time did you usually spend doing **moderate** physical activities on one of those days?	_____ hours/day _____ minutes/day	

Walking

Think about the time you spent walking in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

C5	During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?	None	1
		1 Day	2
		2 Day	3
		3 Day	4
		4 Day	5
		5 Day	6
		6 Day	7
		7 Day	8
		Don't Know	77
		Refuse	99
	If None, Don't Know, Refuse **Skip to Q. C7**		
C6	How much time did you usually spend **walking** on one of those days?	_____ hours/day	
		_____ minutes/day	
C7	During the **last 7 days,** how much time did you spent sitting on week days during the **last 7 days**? Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.	_____ hours/day	
		_____ minutes/day	

Sitting

C8	During the **last 7 days**, on how many days did you spent sitting or lying down to watch television, work/play computer, play electronic games?	None	1
		1 Day	2
		2 Day	3
		3 Day	4
		4 Day	5
		5 Day	6
		6 Day	7
		7 Day	8
		Don't Know	77
		Refuse	99
	If None, Don't Know, Refuse **Skip to Q. D1**		
C9	How much time did you usually spend **sitting** on one of those days?	_____hrs/day	
		_____min/day	

SECTION D

Section of Lifestyle

D1	Have you ever smoked cigarettes/cigars/biddies?	**Go to D13**←Never	1
	2- At what age did you start smoking? _____ yrs 3- For how many years have you/did you smoked? _____yrs 4- When did you quit smoking ?_____ years _____months 5- What was the average number of cigarettes per day that you smoked in the past?_____ cigarettes	Former Smoker	2
	6- At what age did you start smoking? _____ yrs 7- How many years have you/did you smoked? _____yrs 8- How many cigarettes you smoke per day? cigarettes/day _____	Current Smoker	3

	During the last week, How many smoke:	**9-Ciggarettes**	**10-Cigar**	**11-Water pipe or shisha**	**12-Naswar**
	None				
	Once/week				
	2-3 times/week				
	4-5 times/week				
	Every day				

D13	On how many of the past 7 days did someone smoke in your indoor workplace while you were there?	None	1
		Once/week	2
		2-3 times/week	3
		4-5 times/week	4
		Every day	5
		Don't know	77
D14	On how many of the past 7 days did any one smoke in your home while you were there?	None	1
		Once/week	2
		2-3 times/week	3
		4-5 times/week	4
		Every day	5
		Don't know	77
D15	How often are cigarettes smoked inside your home in a typical week?	Never	1
		Once in a week	2
		2-3 times/week	3
		4-5 times/week	4
		Daily	5
		Don't know	77

Section E			
Questions related to diet at home			
E1	Do you add extra salt on your food? **Skip to Q**	Yes ← No	1 2
E2	How often do you add salt on your food?	Occasionally (<7/week) Often (>7/week) Always	1 2 3

3-How often you eat the following food in a day, week, month or year.									
S#	Food item consumed	Use	Frequency					Serving	Your Portion
		1. Yes 2. No	yearly	monthly	weekly	daily	Season /fest		
3-1	Mutton (curry, roasts, etc.)							Plate	
3-2	Beef (curry, roasts, kabab, qeema, barbecued etc.)							Plate	
3-3	Chicken (curry, roasts, tikka, barbecued, broast etc.)							Plate	
3-4	Fish (curry, fry, etc.)							Plate	
3-5	Milk							Glass	
3-6	Lassi							Glass	
3-7	Yogurt (Dahi)/Raita							Cup	
3-8	cheese								
3-9	Other milk products								
3-10	Eggs							Numbers	
3-11	Lentils (Mung, Masoor, etc), Beans (Lobia, Choley)							Plate	
3-12	Raw vegetables/Salad (Tomato, cucumber, onions, reddish/beetroot etc)							Plate	
3-13	Cooked Vegetables (not including potatoes)							Plate	
3-14	Fresh fruits (do not include juices)							Numbers	
3-15	Pure fruit juices: fresh/packaged juices (not including packaged ***Drinks**** like Frost, Frooto etc.)							Glass	
3-16	Sweets							Piece/plate	
3-17	Dry fruits e.g. nuts, peanuts, pista, almonds, chilgoza etc.							Numbers	
3-18	Bread							Numbers	
3-19	Rice							Plate	

SECTION F		
Physical Examination		
Have you smoked a cigarette or taken coffee or tea in the last 30 minutes?	Yes	1
	No	2

	BP		
	Systolic BP	Diastolic BP	Pulse
1st reading	_____	_____	_____
2nd reading after 05 minutes of 1st one	_____	_____	_____
3rd reading after 05 minutes of 2nd one	_____	_____	_____

Anthropometric Measurements		
	1st reading	**2nd reading**
Height	_____cm	_____cm
Weight	_____Kg	_____Kg
Waist circumference	_____cm	_____cm
Hip circumference	_____cm	_____cm

SECTION G					
LABORATORY TESTS RESULTS					
	Test Date			**Report Number**	
G1	Glucose Fasting		G2	Serum Cholesterol	
G3	LDL		G4	HDL	
G5	TGs		G6	Hb1C	

Appendix 5: Developed Developing Countries Partnership for Non-Communicable Disease Prevention

تعاون الدول المتطورة والدول النامية للوقاية من الامراض غير الانتقالية

دراسة حول تعاون الدول المتطورة والدول النامية للوقاية من الامراض الغير انتقالية

الاستبيـــــان

الخاص بأولياء الأمور

أ) أسئلة عامة

اسم الباحث وتوقيع :_____**اسم المشرف وتوقيع:**_____

تاريخ المقابلة: ..... **الوقت:** .....

اسم الطالب:_____**رقم الطالب:**_____

الصف والمرحلة الدراسية:_____

اسم المدرسة : _____

اسم المشارك (الأب أو الأم):_____**رقم بطاقة التأمين الصحي**_____

1-الجنس: 1-☐ ذكر 2-☐ أنثى

2-الجنسية: 1-☐ الإمارات 2-☐ أخرى/حدد:_____

3-تاريخ الميلاد (اليوم | الشهر | السنة):__ __/__ __/__ __ **أو العمر بالسنوات :**.....

5-المستوى التعليمي لولي أمر الطالب

1- ☐ لا يقرأ ولا يكتب 2- ☐ ابتدائي 3- ☐ اعدادي 4- ☐ الثانوي

5- ☐ معهد/جامعة/ دراسات عليا (ماجستير/دكتوراه)

6-الحالة الاجتماعية الحالية لولي الأمر؟

1- ☐ متزوج 2- ☐ مطلق 3- ☐ أرمل 4- ☐ لا يعلم 5- ☐ رفض الإجابة

7-هل هناك قرابة دم بينك وبين زوجك/زوجتك؟

1- ☐ نعم 2- ☐ لا

8-اذا كان الجواب نعم، ما هو نوع القرابة بينك وبين زوجك/زوجتك؟

1- ☐ من الدرجة الاولى 2- ☐ من الدرجة الثانية 3- ☐ أقارب من بعيد

9-كم عدد أولادك وبناتك ؟ أولاد: _____ بنات: _____

10-هل تعيش مع أولادك في

1- ☐ عائلة ممتدة (الزوج-الزوجة-الأولاد-الجد والجدة-اقارب آخرين)

2- ☐ عائلة مفردة (الزوج-الزوجة-الأولاد فقط)

11-ما هي لغتك الأم (لغة الأباء والاجداد):.....

12-هل انت تعمل حاليا؟

1- ☐ نعم 2- ☐ لا

*** اذا كان الجواب نعم**

13-ما نوع العمل/الوظيفة؟ _____

14-كم هو عدد السنوات التي قضيتها في هذا العمل؟_____

15-ما هو معدل دخلك الشهري؟ _____

*** اذا كان جوابك لا ،**

16-ما هو سبب عدم انخراطك بالعمل؟

1- ☐ لا ازال طالبا 2- ☐ ربة منزل 3- ☐ متقاعد

4- ☐ لا أجد عمل 5- ☐ غير ذلك, حدد_____

17-هل تمتلك البيت الذي تعيش فيه؟

1- ☐ نعم 2- ☐ لا

18-كم شخص يعيش معك في المنزل: .....

ب) الصحة العامة

نود الان ان نسألك عن صحتك

1-هل تستطيع أن تصف لي الوضع الصحي العام لك على أنه

1- ☐ ممتاز 2- ☐ جيد جدا 3- ☐ جيد

4-☐ متوسط 5- ☐ ضعيف

2-كم أنت سعيد في حياتك؟

1- ☐ سعيد جدا 2- ☐ سعيد 3- ☐ متوسط

4- ☐ غير سعيد 5- ☐ أبدا لا أشعر بالسعادة

ضغط الدم

3-هل فحصت ضغط الدم من قبل؟

1- ☐ نعم 2- ☐ لا

4-هل تم اخبارك من قبل طبيب او اي اختصاصي ان لديك ضغط دم مرتفع؟

1- ☐ نعم 2- ☐ لا **إذا كان الجواب ب لا انتقل الى السؤال رقم 10**

5-كم كان عمرك عندما أخبرت بأن ضغط الدم لديك مرتفع؟ العمر بالسنوات .....

6-هل وصف لك دواء او علاج لضغط الدم المرتفع؟

1- ☐ نعم 2- ☐ لا

7-هل تتناول حاليا اي دواء لتخفيض ضغط الدم (خلال الشهر الأخير) ؟

1- ☐ نعم 2- ☐ لا

8-أرجو كتابة اسماء الادوية التي تتناولها لعلاج ضغط الدم (الاسم والنوع والجرعة وعدد المرات):

الرقم	اسم الدواء	النوع (1-حبوب 2-كبسولات 3-شراب 4-حقن 5-بخاخ 6-غير ذلك)	الجرعة	عدد المرات في اليوم
1				
2				
3				
4				
5				

9-هل تناولت دواء لتخفيض ضغط الدم في اليومين الاخيرين؟

1- ☐ نعم-اليوم 2- ☐ نعم-اليومين الأخيرين

3- ☐ لا-لم اتناول الدواء في اليومين الأخيرين (**ما هو السبب** .....

.....)

10-هل تم اخبار احد اقربائك (اب, ام, اخ, اخت, ابن, ابنة) من قبل طبيب او اختصاصي ان لديه ضغط دم مرتفع؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

مرض القلب

11-هل تم اخبارك من قبل طبيب او اختصاصي انك تعاني من مرض القلب؟

1- ☐ نعم 2- ☐ لا **<u>إذا كان الجواب ب لا انتقل الى السؤال رقم 16</u>**

12-هل هذا المرض هو؟

1- ☐ ذبحة صدرية 2- ☐ نوبة قلبية 3- ☐ غير ذلك-حدد .....

13-كم كان عمرك عندما اخبرت بذلك: العمر بالسنوات.....

14-هل وصف لك علاج لمرض القلب؟

1- ☐ نعم 2- ☐ لا

15-هل كان العلاج الذي وصف لك

1- ☐ دواء فقط 2- ☐ دواء مع جراحة قلب 3- ☐ غير ذلك-حدد .....

16-هل تم اخبار أحد اقربائك (اب, ام, اخ, اخت, ابن, ابنة) من قبل طبيب او اختصاصي انه تعرض لنوبة قلبية قبل سن ال 55؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

مستوى الدهنيات (الكوليسترول و التريغسيريد)؟

17-هل تم فحص مستوى الدهنيات لديك من قبل (الكوليسترول او التريغسيريد)؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

18-هل تم اخبارك من قبل طبيب او اي اختصاصي ان لديك نسبة عالية من الكوليسترول في الدم؟

1- ☐ نعم 2- ☐ لا **<u>إذا كان الجواب ب لا انتقل الى السؤال رقم 20</u>**

19-هل تتناول حاليا اي دواء لتخفيض نسبة الكوليسترول في الدم؟

1- ☐ نعم 2- ☐ لا

مرض الكلى

20-هل تم اخبارك من قبل طبيب او اي اختصاصي انك تعاني من مرض الكلى؟

1- ☐ نعم 2- ☐ لا **اذا كان الجواب ب نعم،**

21-ما هو هذا المرض؟ حدد .....

مرض السكري

22-هل تم اخبارك من قبل طبيب او اي اختصاصي انك تعاني من مرض السكر؟

1- ☐ نعم 2- ☐ لا **إذا كان الجواب ب لا انتقل الى السؤال رقم 29**

23-كيف تم تشخيص أو اكتشاف مرض السكري لديك؟

1- ☐ وجود أعراض مرض السكري 2- ☐ أرتفاع سكر الدم 3- ☐ أرتفاع سكر البول

4- ☐ غير ذلك ، حدد .....

24-كم عدد السنوات منذ تم تشخيص أو اكتشاف مرض السكري لديك؟

عدد السنوات ..... **(ضع 0 في حال المدة أقل من سنة)**

25-هل وصف لك علاج معين أو حمية غذائية لخفض مستوى السكر او لعلاج السكري لديك؟

1- ☐ نعم 2- ☐ لا

26-اذا كان الجواب ب نعم، هل تخضع حاليا الى أي من الآتي لخفض مستوى السكر او لعلاج السكري لديك؟

1- ☐ حقن الانسولين 2- ☐ حبوب 3- ☐ حمية غذائية

4- ☐ غير ذلك-حدد .....

27-هل تناولت دواء لتخفيض سكر الدم اليوم أو خلال اليومين الاخيرين؟

1- ☐ نعم-اليوم 2- ☐ نعم-اليومين الأخيرين

3- ☐ لا-لم اتناول الدواء في اليومين الأخيرين (ما هو السبب .....

28-هل تستخدم جهاز فحص السكر في المنزل فحصت من قبل نسبة السكر (الغلوكوز) في الدم او البول؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

29-هل تم اخبار احد اقربائك (اب, ام, اخ, اخت, ابن, ابنة) من قبل طبيب او اختصاصي انه يعاني من مرض السكري؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

1- ☐ نعم 2- ☐ لا

السكتة دماغية Stroke

30-هل تم اخبارك من قبل طبيب او اختصاصي انك تعرضت لسكتة دماغية؟

1- ☐ نعم 2- ☐ لا 3- ☐ لا اعلم

31-هل تعلم سبب السكتة الدماغية؟

1- ☐ نعم 2- ☐ لا **<u>إذا كان الجواب ب نعم ،</u>**

32-ما هو السبب الرئيسي للسكتة الدماغية؟ .....

33-هل تم اخبار احد اقربائك (اب, ام, اخ, اخت, ابن, ابنة) من قبل طبيب او اختصاصي انه تعرض لسكتة دماغية؟

1- ☐ نعم 2- ☐ لا

الاصابات Injury

34-هل تعرضت لأي اصابة خلال ال 12 شهرا الماضية <u>مما استدعى تلقي العلاج لهذه الاصابة</u>؟

1- ☐ نعم 2- ☐ لا

35-كيف حدثت الاصابة؟ .....

36-أين حدثت الاصابة؟ .....

37-ما هو سبب هذه الاصابة؟ .....

38-اين تلقيت العلاج ل هذه الاصابة؟

1- ☐ مستشفى حكومي 2- ☐ الرعاية الصحية (المراكز الصحية)

3- ☐ المستشفيات الخاصة 4- ☐ غير ذلك، حدد .....

صحة الاب والام

39-كيف تقيم صحة الاب؟

1- ☐ جيدة

2- ☐ مريض، حدد ما هو المرض .....

3- ☐ متوفي: حدد سبب الوفاة .....

40-كيف تقيم صحة الام؟

1- ☐ جيدة

2- ☐ مريضة، حدد ما هو المرض .....

3- ☐ متوفية: حدد سبب الوفاة .....

ج) الأنشطة الجسدية (الرياضية)

سوف أسألك عن الوقت الذي قضيته في نشاط بدني خلال ال 7 أيام الماضية.

الرجاء إجابة كل سؤال حتى لو كنت لا تعتبر نفسك بأنك شخص نشيط .اعتبر الأنشطة التي تقوم بها في العمل ، الانتقال من مكان إلى آخر ، وفي وقت فراغك للإستجمام ، التمرينات الرياضية أو الألعاب الرياضية.

والآن فكر في جميع الأنشطة التي تحتاج إلى جهد بدني شاق والتي قمت بها خلال ال 7 أيام الماضية

الأنشطة التي تحتاج إلى جهد بدني شاق تجعلك تتنفس بصعوبة أكثر كثيرا من التنفس المعتاد وقد تشمل حمل الأثقال، الحفر، الأيروبك، ركوب الدراجة بسرعة.

1-خلال الـــ 7 أيام الماضية, ما هو عدد الأيام التي قام طفلك خلالها بأنشطة بدنية تحتاج الى جهد بدني شاق, مثل العب في الأندية الرياضية أو الشارع, ركوب المزلجة أو ركوب الدراجة بسرعة (لمدة 10 دقائق على الأقل)؟ (الأنشطة التي تحتاج الى جهد بدني شاق تجعل تنفسك بطريقة أصعب كثيرا من المعتاد)

1- ☐ ولا مرة	2- ☐ يوم
3- ☐ يومان	4- ☐ 3 أيام
5- ☐ 4 أيام	6- ☐ 5 أيام
7- ☐ 6 أيام	8- ☐ 7 أيام
77- ☐ لا يعلم	99- ☐ رفض الاجابة

أذا أجاب بـ (ولا مرة, لايعلم, رفض الاجابة) انتقل الى سؤال رقم 3

2-كم من الوقت تستغرق عادة في عمل الانشطة البدنية التي تحتاج الى جهد بدني شاق في يوم من تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

3-خلال الـــ 7 أيام الماضية, ما هو عدد الأيام التي قمت خلالها بأنشطة بدنية معتدلة, مثل قفز الحبل, التزلج على الجليد في مجمع تجاري أو مراكز التزلج, أو ركوب الدراجة بسرعة عادية (لمدة 10 دقائق على الأقل)؟ لا تقم بتضمين المشي. (الأنشطة التي تحتاج الى جهد بدني معتدل تجعل تنفسك بصورة أصعب بعض الشي من المعتاد)

1- ☐ ولا مرة	2- ☐ يوم
3- ☐ يومان	4- ☐ 3 أيام
5- ☐ 4 أيام	6- ☐ 5 أيام
7- ☐ 6 أيام	8- ☐ 7 أيام
77- ☐ لا يعلم	99- ☐ رفض الاجابة

أذا أجاب بـ (ولا مرة, لايعلم, رفض الاجابة) انتقل الى سؤال رقم 5.

4-كم من الوقت تستغرق عادة في عمل الانشطة البدنية التي تحتاج الى جهد بدني معتدل في يوم من تلك الأيام؟

_____ساعة في اليوم

_____دقيقة في اليوم

5-خلال الـــ 7 أيام الماضية, ما هو عدد الأيام التي قمت خلالها <u>بالمشـــي</u>, لمدة 10 دقائق على الأقل؟ ويشمل ذلك المشي في العمل, في المنزل, المشي للتنقل من مكان الى آخر, أو اي مشي أخر قد تقوم به لمجرد الترفيه, الرياضة, التمرينات البدنية أو في وقت الفراغ؟

1- ☐ ولا مرة	2- ☐ يوم
3- ☐ يومان	4- ☐ 3 أيام
5- ☐ 4 أيام	6- ☐ 5 أيام
7- ☐ 6 أيام	8- ☐ 7 أيام
77- ☐ لا يعلم	99- ☐ رفض الاجابة

<u>أذا أجاب بـــ (ولا مرة, لايعلم, رفض الاجابة) انتقل الى سؤال رقم 7</u>

6- كم من الوقت تستغرق عادة في <u>المشـــي</u> في يوم من تلك الأيام؟

_____ **ساعة في اليوم**

_____ **دقيقة في اليوم**

7-خلال الـــ 7 أيام الماضية, كم من الوقت قضيته <u>جالسا في يوم من أيام الأسبوع</u>, قم بتضمين الوقت الذي قضيته جالسا في المدرسة, في البيت, خلال أداء الواجبات المدرسية, وأثناء وقت الفراغ, ويشمل أيضا الجلوس في المكتب, عند زيارة الأصدقاء, عند القراءة, عند الحديث بالهاتف, لا تضمن الاستلقاء أو الجلوس لمشاهدة التلفاز, العمل/اللعب بالحاسوب, ولعب الألعاب الالكترونية ؟

_____ **ساعة في اليوم**

_____ **دقيقة في اليوم**

8-خلال الـــ 7 أيام الماضية, ما هو عدد الأيام التي قضيتها بالجلوس أوالاستلقاء لمشاهدة التلفاز, العمل/اللعب بالحاسوب, ولعب الألعاب الالكترونية ؟

1- ☐ ولا مرة	2- ☐ يوم
3- ☐ يومان	4- ☐ 3 أيام
5- ☐ 4 أيام	6- ☐ 5 أيام
7- ☐ 6 أيام	8- ☐ 7 أيام
77- ☐ لا يعلم	99- ☐ رفض الاجابة

<u>أذا أجاب بـــ (ولا مرة, لايعلم, رفض الاجابة) انتقل الى سؤال 1-التدخين</u>

9-كم من الوقت تستغرق عادة في بالجلوس أوالاستلقاء لمشاهدة التلفاز, العمل/اللعب بالحاسوب, ولعب الألعاب الالكترونية

_____ **ساعة في اليوم**

_____ **دقيقة في اليوم**

د) نمط الحياة-التدخيـــــن

1- هل دخـــنت في يوم من الأيام (سيجارة ، سيجار، مدواخ، شيشة، نسوار)؟

1- ☐ أبدا — **إنتقل الى السؤال رقم 13**

2- ☐ مدخن سابق

2- **كم كان عمرك عندما بدات بالتدخين؟** _____
3- **عدد سنوات التدخين؟** _____
4- **منذ متى اوقفت التدخين؟** _____سنة _____ شهر
5- **ما هو معدل عدد السجائر التي كنت تدخنها في اليوم الواحد؟** العدد_____

3- ☐ مدخن حالي

6- **كم كان عمرك عندما بدات بالتدخين؟** العمر بالاعوام _____
7- **كم هو عدد السنوات التي دخنت خلالها؟** _____ سنة
8- **ما هو معدل عدد السجائر التي تدخنها في اليوم الواحد؟** العدد _____

خلال الاسبوع الماضي, كم مرة دخنت:	9-السيجارة؟	10-السيجار؟	11-النارجيلة او الشيشة؟	12-النسوار؟
ولا مرة				
مرة واحدة في الاسبوع				
2-3 مرات في الاسبوع				
4-5 مرات في الاسبوع				
كل يوم				

13-كم يوما خلال الايام السبعة الماضية دخن شخص ما في مكان مغلق بينما انت كنت هناك؟

1- ☐ ولا مرة
2- ☐ مرة واحدة في الاسبوع
3- ☐ 2-3 مرات في الاسبوع
4- ☐ 4-5 مرات في الاسبوع
5- ☐ يوميا
77- ☐ لا يعلم

14-كم يوما خلال الايام السبعة الماضية دخن شخص ما في بيتك بينما انت كنت هناك؟

1- ☐ ولا مرة
2- ☐ مرة واحدة في الاسبوع
3- ☐ 2-3 مرات في الاسبوع
4- ☐ 4-5 مرات في الاسبوع
5- ☐ يوميا
77- ☐ لا يعلم

15-كم مرة يتم تُدخن السجائر داخل منزلك في الاسبوع بشكل عام (ليس فقط الاسبوع الماضي)؟

1- ☐ ولا مرة
2- ☐ مرة واحدة في الاسبوع
3- ☐ 2-3 مرات في الاسبوع
4- ☐ 4-5 مرات في الاسبوع
5- ☐ يوميا
77- ☐ لا يعلم

هـ)الأغذية المنزلية

1-هل تضع ملح بشكل اضافي على طعامك؟ هل تضع ملح بشكل اضافي على طعامك؟

1- ☐ **نعم** 2- ☐ **لا**

2-كم مرة تضيف الملح على الطعام؟

1- ☐ **احيانا (اقل من 7 بالاسبوع)** 2- ☐ **كثيرا (اكثر من 7 بالاسبوع)** 3- ☐ **دائما**

3- كم تتناول هذه الاطعمة سواء سنويا-فصليا-شهريا-اسبوعيا أو يوميا

رقم	الصنف	استخدام	تكرار الاستخدام					المقياس	الكمية التي تناولت
		نعم ☐ لا ☐	سنويا	شهريا	اسبوعيا	يوميا	فصليا		
1-3	**لحم ضأن (مطبوخ، مشوي، .....)**							صحن	
2-3	**لحم بقري (مطبوخ، مشوي، كباب، قيما)**							صحن	
3-3	**دجاج (مطبوخ، مشوي، تكا، ....)**							صحن	
4-3	**سمك (مطبوخ، مقلي، ....)**							صحن	
5-3	**الحليب**							كوب 200 مل	
6-3	**لبنه**							ملعقة	
7-3	**لبن (روب)**							كوب 200 مل	
8-3	**أجبان**							عدد/قطعة	
9-3	**منتجات الحليب الأخرى .....**							تحدد لاحقا	
10-3	**البيض**							عدد	
11-3	**عدس بأنواعه، الفاصوليا واللوبيا، .....**							صحن	
12-3	**الخضراوات الطازجة/السلطات (طماطم، خيار، بصل،**							صحن	
13-3	**الخضراوات المطبوخة (لا تشمل البطاطا)**							صحن	

14-3	**الفواكه الطازجة (لا تشمل العصائر)**							عدد	
15-3	**عصائر الفواكه الطازجة: طازجة/معلبة، ولا تشمل شراب الفواكه**							كوب 200 مل	
16-3	**الحلويات (الحلاوة)**							عدد/صحن	
17-3	**الفواكه المجففة(التمر والمشمش، العنب ... المكسرات الفول السوداني والفستق واللوز..**							عدد	
18-3	**خبز**							عدد	
19-3	**رز**							صحن	

و) القياسات الحيوية

(يتم أخذ القياسات من قبل الممرض/الممرضة حسب المعايير المتفق عليها)

هل دخنت سيجارة او شربت شاي او قهوة خلال الثلاثين دقيقة الماضية؟

1- ☐ نعم 2- ☐ لا

ضغط الدم والنبض

(ثلاث مرات مع مراعاة خمس دقائق بين كل قراءة واخرى)

(يرجى أخذ القياسات بعد تعبئة الاستبيان واستخدام شريط القياس المناسب)

	ضغط الدم الانبساطي	ضغط الدم الانقباض	النبض (Pulse)
القراءة الأولى:	_____	_____	_____
القراءة الثانية:	_____	_____	_____
القراءة الثالثة:	_____	_____	_____

الطول والوزن ومحيط الخصر والحوض

(يرجى التأكد من أن الشخص يقف منتصبا وكذلك لا يلبس ملابس ثقيلة)

	القراءة الأولى	القراءة الثانية
الطول (سم)	_____	_____
الوزن (كجم)	_____	_____
قياس الخصر (سم)	_____	_____
قياس محيط الحوض (سم)	_____	_____

ز) الفحوصات المخبرية

الفحوصات المخبرية **رقم المشارك----------**

ملاحظة: سوف يتم فحص الاطفال من عمر 6 الى 11 سنة في حضور احد الوالدين (ام/اب) من بعد الحصول على موافقة الطفل واهله.

1. **نسبة الغلوكوز بعد الصوم_____**
2. **نسبة الكولسترول _____**
3. **LDL_____**
4. **HDL_____**
5. **التريغلسريد_____**
6. **HbA1C:_____**

Appendix 6: Consent form in Arabic

جامعه الامارات العربية المتحدة
كليه الطب والعلوم الطبية

التاريخ: / / 20

اقرار بالموافقة

دراسة حول تعاون الدول النامية والدول المتقدمة للوقاية من الأمراض المزمنة

الاهالي الأعزاء،

نحن اعضاء في هيئة التدريس في جامعة الامارت العربية المتحدة نخطط لاجراء دراسة هدفها اكتشاف العوامل الخطرة التي تؤدي الى أمراض لقلب والسكري التي تظهر عادة مع تقدم العمر لكن جذورها تعود الى الطفولة.نمط الحياة غير السليم مثل الاكل غبر الصحي وقلة الحركة كلها عوامل من الممكن أن تؤدي للاصابة بالسكري وامراض القلب.لذا من المهم ان يكون الاهل على وعي تام بوجود أي من العوامل الجطرة الممكنة المؤدية لامراض القلب.

في هذه الدراسه، نحن ندعو أطفالكم مع أهاليهم (الام والاب) لاجراء فحص طبي من الدراسة (تعاون الدول النامية والدول المتقدمة للوقاية من الامراض المزمنة). هذه الدراسه ستساعدنا لانشاء برامج وقائية من امراض القلب والسكري في مجتمعنا. سوف يتم جمع المعلومات عن العوامل الخطره التي تؤدي الى الأمراض المزمنة باستخدام استبيان. القياس السريري يتضمن قياس ضغط الدم والوزن والطول كما سيتم أخذ عينه من الدم لمعرفه. العوامل الخطره المؤذيه الى أمراض القلب. سوف يقوم ممرض متمرس لسحب الدم.

الفحص الطبي سيكون مجانيا. والمعلومات التي سوف تعطونها سنبقى كيد الكتمان. أن مشاركه في هذه الدراسه اختياري. يمكنكم رفض المشاركه او الانسحاب قِي أي وقت.

نحن نقدر مشاركتكم معنا لإتمام هذه الدراسة.

موافقه الوالد/الوالده: **موافقه الطفل:**

أوافق على الموافقة شخصيا أوافق على مشاركة ابني/ابنتي في الدراسة

الاسم: _____ اسم الابن/الابنه: _____

الإمضاء: _____ امضاء الوالد/الوالده: _____

موافقه على المشاركه مستقبلا وتزويد بنتائج الفحوصات:

التوقيع:.....…..... Email:……

اسم الممرض او منسق هذه الدراسه:

الاسم :_____ الإمضاء:_____

Appendix 7: DM prevention questionnaire

Adults with Pre-diabetes (Fasting PG 100-125 mg/dl or HbAIC 5.7-5.4)

Q1. Patient Name:----------الاسم

Q2. Contact address. House number----------رقم المنزل Street name and Number----------رقم اسم الشارع

Q3. Cell Phone (from file and no need to ask the patient)----------النقال-رقم الهاتف

Q4. Email Address (of available if less than 50 years)---------- البريد الالكتروني

Q5.house phone number:----------رقم هاتف المنزل

Q6. Patient ID (from file and no need to ask the patient)----------رقم البطاقه

Q7.last visit Date: ----------\Dayيوم---------\Monthشهر---------\Yearسنه---------- اخر زيارة للعيادة

Q8 .what was the fasting glucose level-------, معدل سكر الدم Q8b A1C level---------- معدل السكر التراكمي

-Q9. Date of birth or Age----------العمر اقو تاريخ الميلاد

Q10. Gender(from file and no need to ask the patient) . (tick) Male ( ) Female 2 ( ) الجنس

Q11. Marital status 1 Single غير متزوج ( ) 2 married متزوج ( ) 3 widowed ارملة ( ) 4 Divorced مطلق(الحالة الاجتماعية

Q12. Occupation (Job)? المهنه House wife 1ربه منزل( ) 2Health care مهني صحي ( ) 3 Army\policeشرطي\عسكري ( ) 4. Office job ( ) 5. Business ( )

6. Others jobs (specify)مهن اخرى----------

Q13. Education (tick) (formal schooling) مستوى التعليم

1 2 3 4 5 6 7 (primary) الابتدائية 8 9 10 11 12 (high school) الثانويه ( ) (college) جامعي ( ) (university) ( ) no schoolامي

<u>Risk assessment تقييمالمخاطر</u>

Q14 Are you physically active (at least 30 minutes daily at work or during leisure time)?

YES ( ) No ( ) هل امارس الرياضة على الاقل 30 دقيقع يوميا خلال العمل او للترفيه

Q15 how often do you eat vegetable or fruits?كم مرة تتناول الخضروات والفواكه

Every day ( ) كل يوم not every day ( )ليس كل يوم

Q16 do have high BPor hypertension?هل تعاني من ارتفاع في ضغط الدم

YES ( ) No ( )

If Yes

Q17Are you taking medication for high BP?هل تتناول دواء لارتفاع ضغط الدم

YES ( ) No ( )

Q18 For married people only: have you ever been found to have high glucose during pregnancy? (do not ask the question is the patient is single or male) للمتزوجات فقط:هل كنت تعاني من ارتفاع في نسبة السكر اثناء الحمل

YES ( ) No ( )

Q19 have your family members (parents, brothers, sisters) been diagnosed with diabetes?

YES ( ) No ( )هل لديك اقرباء من الدجة الاولى (والدين اخ اخت) يعانون من ارتفاع في مرض السكري

Q20 have your other relative (second degree relative grandfather, aunt, uncle, first cousin) been diagnosed with diabetes? YES ( ) No ( ) هل لديك اقرباء من الدجة الثانية (جد جدة عم خال عمه خالة) يعانون من ارتفاع في مرض السكري

Q21 have your doctor ever told you that you have diabetes? YES ( ) No ( ) هل قام طبيبك باخبارك بانك تعاني من مرض السكري

If yes

Q22 if yes, how long you have been told that you have diabetes? ما هي الندة التي تعاني منها من مرض السكري

Month-------years-------

Q23 were you prescribed any treatment foe diabetes? YES ( ) No ( ) هل تتناول الدواء لمرش السكري

Q24 if yes what type of treatment?اذا نعم. ما نوع العالج الذي تاخذه لعالج السكري

Diet ( )الحمية الغذائية Tablet ( )حبوب insulin injection ( )ابر الانسولين

Q25 Do you have a blood sugar device checking device at you home? YES ( ) No ( ) هل لديك جهاز لفحص السكر بالمنزل؟(

Q26 Do you smoke cigarettes? Never ( ) Yes currently ( ) yes in the past ( ) هل تدخن السيجارة؟

Q27 Do you smoke shisha? Never ( ) Yes currently ( ) yes in the past ( ) هل تدخن الشيشه

Q28 Do you smoke Medyat? Never ( ) Yes currently ( ) yes in the past ( ) هل تدخن المدواخ

International physical acitivty questionnaire:

Q29 during the last 7 days, on how many days did you walk for at least 10 minutes at a time?

Number of days in a week------ في سبع ايام الماضية هل قمت بممارسة رياضة المشي لمدة 10 دقائق؟-

Q30 how long do you usually spend walking on one of these days? الوقت المستغرق في المشي لليوم الواحد

Hours-------minutes-----

Q31 During the last 7 days how many days did you spend doing moderate activates such as cycling or playing a game which will make you breathe somewhat harder than normal?

Number of days------ في سبع ايام الماضية هل قمت بممارسة رياضة كالدراجة او اي رياضه او لعبة ذات مجهود متوسط بحيث تزيد من سرعه التنفس لديك ؟-

Q32 how long do you usually spend doing moderate activity on of these days?

Hours-----minutes---لليوم الواحد-الوقت المستغرق لممارسة تلك الرياضه

Q33 During the last 7 days how many days did you spend doing vigorous activates for at least 10 minutes at a time such as running or playing football or other game which will make you breathe somewhat harder than normal? في سبع ايام الماضية هل قمت بممارسة رياضة قاسية كلعب الكرة او الجري السريع بحيث تزيد من سرعه التنفس لديك

Number of days------

Q34 how long do you usually spend doing vigorous activity on of these days?

Hours-----minutes----الواحد-الوقت المستغرق لمم