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# PREVALENCE OF DIABETES AND PREDIABETES IN PAKISTAN

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**Abstract:**
***Aims:*** *To determine the prevalence of type 2 diabetes mellitus and prediabetes among the population aged 40-74 years in Pakistan.*
***Methods:*** *This population-based cross-sectional survey, conducted between 2017 and 2018, invited 2186 randomly selected individuals Subjects were screened using finger capillary blood for glycosylated hemoglobin, type A1C, non-fasting random plasma glucose, fasting plasma glucose followed by oral glucose tolerance test. The test was based on an algorithm that accounts for screening, diagnostic and confirmatory steps. Anthropometric measures and a questionnaire including medical history, medication, hereditary conditions, and food intake were included.*
***Conclusions*** *The prevalence of diabetes and prediabetes increased with age and were more frequent among men.*
**Keywords:** *Type 2 diabetes mellitus; prediabetes; Faroe Islands; prevalence; diagnostic criteria; population-based.*

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## INTRODUCTION:

The prevalence of diabetes is increasing worldwide but varies between countries. A recent report published by the World Health Organization (WHO) estimated that, globally, 422 million adults were living with diabetes; an increase from 4.7% in 1980 to 8.5% in 2014, an aging population is likely not the only culprit attributed to this increase [1].

In the USA and Canada the prevalence of diabetes among adults aged 20-79 years – based on a population level study - was estimated in 2010 to be 12.3% and 11.6% respectively, whilst the estimate was 4.9% in United Kingdom and 12.0% in Germany [2]. Lower prevalence rates have been observed among Nordic countries. For example, in Sweden and Norway the prevalence of type 2 diabetes (T2D) was estimated to be 3.5% and 3.8%, respectively and in Denmark for diabetes in general, to 5.7%, based on data from the diabetes registries and digital medical records [3-5]. To date, there is no clear evidence on these regional disparities in T2D prevalence.

One theory suggests that the disparities may be a reflection of the methodologies, ages of the subjects, and/or diagnostic criteria used. Thus, Bernal-Lopez and colleagues [6] concluded that glycosylated hemoglobin, type A1c (HbA1c) rather than fasting plasma glucose (FPG) for diagnosis of prediabetes would offer better sensitivity. The population is fairly homogenous due to centuries of isolation [7], which has led to an increased incidence of certain hereditary diseases like carnitine transporter deficiency (CTD) and cystic fibrosis [8,9].

Genetic predisposition seems important in the etiology of T2D [10,11] but has not yet been studied in the Faroe Islands. Consequently, the aim of this study to determine the prevalence of T2D among Pakistanis between the ages of 40 and 74 years

## METHOD:

This study is a national, cross-sectional, population-based survey conducted in 2017- 2018. The study population was an age-adjusted, random sample selected from the Pakistan .Addresses from 2,186 men and women aged 40-74 years (11.1% of the population) were randomly selected, and 1,772 subjects (81.1%) completed the study protocol. Of the non-participants, 263 declined to participate or were out of reach, 22 lived abroad, 9 died during the recruiting period, 2 had type-1 diabetes, and 118 accepted the invitation but failed to appear. The study was approved by the local ethical review committee, as the risk for T2D increases with age and the prevalence is low before the age of 40 years, this study included subjects from the age of 40 years.

The screening program was based on a diagnostic algorithm (Fig. 1) designed by the ADDITION study group.

The blood glucose concentrations were analyzed using a HemoCue Glucose 201 RT Analyzer which is equipped with an inbuilt fixed calibration. Two blood samples were taken for all tests and the average of the two results was used to minimize the measurement error. If the discrepancy was ≥ 0.5 mmol/L a third blood sample was taken to calculate the mean. An Afinion AS100 Analyzer (HemoCue AB, Ängelholm, Sweden) was used to analyze HbA1c.
The anthropometric measurements were available for all individuals. These include body weight (in kg), and height, waist and hip circumference (in cm).. Questionnaire Individuals with high RPG concentrations (≥ 12.2 mmol/L), high FPG concentrations (≥ 6.1 mmol/L), high HbA1c (≥ 5.8% (40 mmol/mol)) and known type 2 diabetes (K-T2D), as well as a number of subjects in the Low risk group answered a questionnaire (n= 567). 2 individuals failed to hand in the questionnaire.

### Statistical Methods:

The statistical analyses were performed using the IMB SPSS Statistics for Windows (version 24.0) Descriptive results are presented with mean and standard deviations (SD) for continuous variables and as a percentage for categorical variables. The Chi-square test was applied for categorical variables and student's t-test for continuous variables, after normality was assessed by visual inspection of plots and by Kolomogorov– Smirnov test.

## RESULTS:

The study population comprised 839 women and 933 men with a mean age of 55.3 (range 40- 74) years. There was no difference between the participants and non-participants in regard to sex, age, and place of residence. The crude prevalence and the 95% confidence interval (CI) for diabetes was 9.5% (95% CI: 8.2%; 10.9%) and the age-adjusted was 9.6% (95% CI: 8.2; 11.0) with 3.0% (95% CI: 2.2%; 3.8%) being N-T2D, indicating that 31.4% (95% CI: 24.4%; 38.3%) of diabetes cases were undiagnosed.
Prediabetes was found in 15.3% (95% CI: 13.6%; 17.0%) of the participants, including those with NGT. The latter group had HbA1c ≥ 5.8% (40 mmol/mol) in the 8 screening step and was therefore regarded as prediabetic. Altogether 24.8% (95% CI: 22.9%; 26.9%) of the study population had impaired glucose

regulation. The sex and age-adjusted prevalence for each diagnostic group is presented in Table 1

The total proportion with abnormal values increased approximately 4.5 fold from the youngest age group (40-49 years) to the oldest (70-74 years). The most salient increase was observed among those with K-T2D, IGT, IFG and NGT. Those in the oldest age group with an IGT were 10-fold greater than in the younger groups and double for the NGT group.

Compared to men, women had a lower, but not significantly so, mean FPG across all age groups. The opposite relationship was observed for 2hPG for the age groups 50-59 and 60-69 years, with women having higher concentrations, again not significantly different, The mean BMI was 28.9 for men and 27.6 for women. Obesity (BMI ≥ 30) was more prevalent among men; 34.5% vs. 26.3% ($p < 0.001$) in women, whereas an abnormal WHR (>1.00 for men and > 0.85 for women) was more prevalent among women; 47.1% vs. 26.4% ($p < 0.001$) in men. As presented in Table 2, the frequency of obesity and an abnormal WHR was significantly higher in the groups with diabetes and the three groups with prediabetes 9 IFG, IGT, and IFG+IGT compared to the NGT and low risk groups.

***Table 1. Age and sex-specific crude prevalence for each diagnostic group.***

| | Age group | | | Age group | | | Age group | | | Age group | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40-49 years | | | 50-59 years | | | 60-69 years | | | 70-74 years | | |
| | Male | Female | p value [e] | Male | Female | p value | Male | Female | *p*-value | Male | Female | *p*-value |
| n | 313 | 284 | | 282 | 266 | | 263 | 225 | | 75 | 64 | |
| | 84.7 | 89.4 | 0.6 | 75.5 | 83.5 | 0.7 | 56.3 | 67.6 | 0.8 | 50.7 | 62.5 | 0.8 |
| **Low risk** | | | | | | | | | | | | |
| **NGT** | **5.8** | **4.9** | **0.5** | **7.1** | **4.9** | **0.2** | **6.5** | **9.8** | **0.4** | **8.0** | **14.1** | **0.4** |
| IFG | 3.2 | 1.8 | 0.2 | 3.9 | 1.9 | 0.1 | 7.6 | 6.2 | 0.3 | 8.0 | 7.8 | 0.8 |
| IFT | 0.6 | 0.4 | 0.6 | 1.4 | 1.9 | 0.7 | 1.5 | 4.9 | 0.07 | 6.7 | 3.1 | 0.3 |
| IFG+IGT | 1.9 | 1.4 | 0.5 | 2.5 | 1.9 | 0.6 | 3.8 | 2.7 | 0.3 | 2.7 | 3.1 | 1.0 |
| N-T2Db | 1.6 | 0.7 | 0.3 | 3.2 | 2.3 | 0.3 | 6.8 | 3.6 | 0.05 | 2.7 | 3.1 | 1.0 |

aThe low risk group is comprised of subjects from Category 1 (54.1%) and those from Category 2 with low random plasma glucose, low HbA1c and low fasting plasma glucose (21.1%), according to the standard algorithm . bNGT, Normal Glucose Tolerance; IFG, Impaired Fasting Glucose; IGT, Impaired Glucose Tolerance; N-T2D, Newly Diagnosed Type 2 Diabetes Mellitus; K-T2D, Previously Known Type 2 Diabetes Mellitus. cThe NGT group had HbA1c ≥ 5.8% (40 mmol/mol) in the screening step of the standard algorithm and will therefore be regarded as having prediabetes. dThe proportions were calculated from the number of participants in each age group and Confidence Interval (95%CI) was calculated in Stata and the numbers were based on logit transformation. e Proportions of men and women in each age group and diagnostic group was tested for significance by one-sample Chi-square Test. The overall age-adjusted prevalence to Northern Europe is 9.6%, for women alone 5.7% and for men 13.0%.

*Table 2. Association between impaired glucose regulation and various major risk factors.*

| | | Low risk | NGT[a] | IFG[a] | IGT[a] | IFG+IGT | N-T2D[a] | K-T2D[a] | *p*-value for trend |
|---|---|---|---|---|---|---|---|---|---|
| *n* | | 1332 | 119 | 76 | 34 | 42 | 53 | 116 | |
| Age, mean | | 53.8 (9.3) (ref.) | 57.6 (9.3) | 59.7 (9.3) | 62.2 (7.4) | 57.5 (9.6) | 59.8 (8.4) | 61.9 (8.0) | $p<0.001$[h] |
| Obesity[b] | % | 25.4 | 32.8 | 46.7 | 50.5 | 61.9 | 66.8 | 50.6 | |
| | OR | 1(ref.) | 1.32 (0.88;1.99) | 2.22 (1.38;3.58) | 2.57 (1.28;5.14) | 4.39 (2.32;8.33) | 4.93 (2.74;8.87) | 2.40 (1.49;3.87) | $p<0.001$[i] |
| Abnormal WHR[c] | % | 31.8 | 43.7 | 46.7 | 64.7 | 52.4 | 73.6 | 48.3 | |
| | OR | 1 (ref.) | 1.54 (1.03;2.31) | 1.86 (1.13;3.06) | 3.07 (1.46;6.47) | 2.50 (1.31;4.78) | 6.70 (3.51;12.8) | 2.32 (1.34;4.01) | p<0.001[i] |
| Hypertension | % | 48.5 | 39.5 | 43.2 | 70.6 | 52.4 | 70.6 | 84.6 | |
| | OR | 1 (ref.) | 0.91 (0.53;1.54) | 0.78 (0.42;1.43) | 2.28 (0.96;5.41) | 1.32 (0.60;2.87) | 2.53 (1.19;5.37) | 6.99 (3.30;14.8) | $p<0.001$[j] |
| Vascular attack | % | 17.5 | 13.6 | 27.0 | 23.5 | 24.4 | 23.5 | 46.2 | |
| | OR | 1 (ref.) | 1.10 (0.55;2.20) | 2.10 (1.05;4.21) | 1.59 (0.62;4.08) | 2.09 (0.86;5.07) | 1.66 (0.73;3.74) | 4.19 (2.20;7.99) | $p=0.001$[j] |
| Smoking[d] | Yes, % | 65.1 | 73.9 | 70.3 | 52.9 | 76.2 | 65.4 | 71.8 | |

## DISCUSSION:

This comprehensive study comprising 11% of the entire population aged 40-74 years is the first to estimate the prevalence of T2D and prediabetes in the Pakistan. The age-adjusted prevalence of T2D found in this study (9.6%) is at the same level (9.8%) as reported by Bjerregaard et al. regarding the population of Greenland age 35+ and slightly higher compared to the same population age 18 and older [12] The Nordic countries have in general a lower prevalence: Iceland (approximately 4% for the age group 45-64 years) [13,] Sweden 3.5% for people age 30+ years, and in Norway and Denmark 3.8% and 5.5% for the entire population, respectively (and the latter including persons with type 1 diabetes).

However, the prevalence was higher in other European countries such as Spain (13.8%), Portugal (11.7%) and Germany (12.0%), as well as in North America; Canada (11.6%) and the United States (12.3%) . In Scotland, the incidence found for age group 40-89 years was 3.4% which is closely aligned with our N-T2D result (3.0%). In Sweden and United Kingdom, the crude prevalence of T2D for these populations (based on medical records, prescriptions for any glucose-lowering drug or primary care registry data) increased from 2.2% in 1996 to 5.3% in 2013. In Sweden, the prevalence changed from 3.5% for people age 30 years and over to 4.4% if the entire population was included. This is lower than the findings in our study, even though the diagnostic criteria for measuring plasma concentrations were based on the same guidelines. Other findings from Sweden estimated a higher prevalence of 7.3% based on OGTT screenings for the age group 25-74 years, which is comparable to our prevalence.

This observation emphasizes the importance of sampling methods and inclusion criteria (e.g. age-span) when comparing overall national prevalence. The screening method also has proven to be an important factor in estimating the prevalence of diabetes and prediabetes. The profile of our NGT group (see Table 2) was comparable to the low risk group in terms of BMI, abnormal WHR, and cardiac and hereditary conditions, but similar in age to the other prediabetic and diabetic groups. Age-related cut-off levels for HbA1c have been proposed to deal with this discrepancy, as HbA1c concentrations increased by 0.074% per decade in non-diabetics. In addition, older subjects with T2D had better functional outcomes with HbA1c levels between 8.0% (64 mmol/mol) and 8.9% (74 mmol/mol), as compared to those between 7.0% (53 mmol/mol) and 7.9% (63 mmol/mol) [28]. In a high-risk Spanish population 8.6% were assessed to have DM when determined by 2hPG, whereas the prevalence decreased to 1.3% when determined by HbA1c.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | (1.00;2.89) | (0.76;2.54) | (0.32;1.46) | (0.94;4.72) | (0.63;2.50) | (0.81;2.80) | |
| Hereditary T2D[e] | % | 25.2 | 36.7 | 35.8 | 46.7 | 36.8 | 44.7 | 55.1 | |
| | OR | 1 (ref.) | 1.72 (1.00;2.95) | 1.65 (0.88;3.07) | 2.68 (1.18;6.06) | 1.69 (0.78;3.68) | 2.38 (1.19;4.75) | 3.49 (1.91;6.37) | $p$=0.004[j] |
| Leisure activity[f] | % | 73.1 | 68.6 | 60.8 | 52.9 | 45.9 | 49.0 | 61.0 | |
| | OR | 1 (ref.) | 0.82 (0.48;1.40) | 0.68 (0.37;1.24) | 0.48 (0.22;1.04) | 0.41 (0.20;0.86) | 0.49 (0.25;0.95) | 0.69 (0.38;1.24) | $p$=0.14[j] |
| Cooked vegetables[g] | % | 78.9 | 79.0 | 79.7 | 79.4 | 76.9 | 66.7 | 79.5 | |
| | OR | 1 (ref.) | 0.76 (0.42;1.39) | 0.92 (0.46;1.85) | 0.78 (0.30;2.02) | 0.67 (0.28;1.61) | 0.45 (0.21;0.93) | 1.10 (0.56;2.17) | $p$=0.41[j] |
| Raw vegetables[g] | % | 49.7 | 49.6 | 43.8 | 52.9 | 50.0 | 33.3 | 46.7 | |
| | OR | 1 (ref.) | 0.75 (0.45;1.24) | 0.71 (0.40;1.26) | 0.96 (0.44;2.09) | 0.83 (0.39;1.73) | 0.47 (0.24;0.95) | 0.99 (0.56;1.75) | $p$=0.44[j] |

[a] See Table 1 footnote 'b' for full names. [b] BMI ≥30 kg/m$^2$. [c]WHR >1.00 for men and > 0.85 for women. [d] Smoking, reporting "Yes" at any time in life. [e] First relative only. [f] Self-reported. [g] Consumed once a week or more. [h] Tested with ANOVA (Bonferroni) and difference in mean age between men and women by Mann-Whitney test, none were significant. [i] Adjusted for sex and age. [j] Adjusted for sex, age and BMI. [k] Adjusted for sex, age, BMI and hypertension.



## CONCLUSION:

In conclusion, 9.5% of the selected population aged 40-74 years was diagnosed to have T2D and 6.5% of the participants were already diagnosed at study entrance. Another 15.3% had glycemic disturbance. The prevalence increased with age for all prediabetic and diabetic groups and was more frequent among men, except NGT for women aged 60 and older.

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