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Evaluate the Risks of Prediabetes and Diabetes in the Elderly by Comparing Different Definitions: An Observational Study

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ABSTRACT:

Aim: The aim of the present study was to compare different prediabetes definitions and characterize the risks of prediabetes and diabetes among older adults.
Material & methods: A random sample of all registered inhabitants aged ≥60 years living at home or in nursing homes were invited to the baseline assessment during the duration of 3 years. 500 diabetes-free participants were included in the study.
Results: Women made up 56.8% of the research, comparing males. Average patient age was 75. All prediabetes criteria have positive predictive values < 12% for incidence complete diabetes. But all negative predictive values were 96% or above. Detecting confirmed diabetes was most sensitive for prediabetes with HbA1c values of 5.7%-6.4% or IFG (≥94%), while specificity was best for those with such levels and IFG (confirmatory definition). Positive predictive values for incident-diagnosed diabetes were below 8% and negative predictive values were 97% or higher. Alternative global definitions of prediabetes have a sensitivity of less than 48% for new total and diagnosed diabetes cases and a specificity of 78% or greater.
Conclusion: The incidence of prediabetes was substantial; yet, during the duration of the trial, a greater number of individuals had a return to normal blood sugar levels or mortality compared to those who developed diabetes. These data indicate that prediabetes may not be a reliable diagnostic category in older individuals.

Keywords: prediabetes, diabetes, older adults

1. INTRODUCTION

The prevalence of prediabetes and diabetes increases considerably as individuals become older.[1] Prediabetes is a condition that precedes the development of type 2 diabetes and is often asymptomatic. It is characterized by hyperglycemia, which is an increased blood glucose level that is above normal but not high enough to be diagnosed as diabetes.[2] The main difference in defining pre-diabetes between the ADA and WHO lies in the variance of the glycemic index threshold. The ADA standard establishes the fasting glucose threshold at 5.6mmol/L, although the WHO defines it at 6.0mmol/L.[3] The prevalence is greater in the elderly than in the younger population.[4,5] Prediabetes is a state characterized by an increased

chance of developing diabetes. Each year, about 5-10% of people with prediabetes may develop diabetes. According to the expert panel of the American Diabetes Association, 70% of patients with prediabetes are expected to acquire diabetes in the future.[6] On the other hand, prediabetes may potentially return to normal blood sugar levels.

Despite being prevalent in older individuals, there is little understanding of the progression of hyperglycemia throughout time, especially when transitioning between normoglycemia, prediabetes, and diabetes. In a We expect the number of people living with prediabetes to rise from 352 million in 2017 (7.3%) to 587 million (8.3%) by 2045.[7]

Identifying and treating prediabetes at an early stage may benefit those at high risk of developing diabetes in the future. Conversely, a different study discovered that in older individuals with prediabetes, the transition to normal blood sugar levels (normoglycemia) occurred more often than the development of diabetes. Therefore, prediabetes may not reliably predict future diabetes issues in older individuals.[8] Adapting one's lifestyle may assist working-age persons in enhancing their glycemic management.[9,10] Glycated hemoglobin A1c (HbA1c) levels rise with age in non-diabetic individuals, and low blood glucose levels may raise the risk of mortality in older adults.[11,12] This research aimed to investigate the prevalence of prediabetes in older persons by monitoring their progression from normal blood sugar levels to prediabetes or diabetes using glycated hemoglobin (HbA1c) levels, fasting glucose (FG) levels, or both.

2. MATERIAL & METHODS

During a 3-year period, a random sample of all registered individuals aged 60 years or older, whether they lived at home or in nursing homes, were invited to participate in the baseline assessment. To account for the faster changes in health conditions and higher attrition rates among older individuals, the sampling process was divided into 11 age cohorts. Both the younger and older age groups were monitored at three-year intervals.

In the present investigation, individuals with pre-existing type 1 or type 2 diabetes were not included, leading to a final sample size of 550 participants without diabetes. In addition, 50 participants declined follow-up examinations or became uncontactable, resulting in a final sample of 500 participants without diabetes who were monitored for a maximum of 12 years. The individuals who discontinued their participation in the study were characterised by being older, predominantly female, having a level of education below elementary school, leading a sedentary lifestyle, consuming less alcohol, and obtaining lower scores on the Mini-Mental State Examination (MMSE) compared to those who remained in the study.

Consent was gained from all individuals or their proxy if they had cognitive impairment. The institutional Ethical committee has granted ethical approval.

Data collection refers to the process of gathering and organising information or data for analysis and interpretation.

Structured interviews and clinical examinations conducted by trained nurses and physicians were used to gather data on demographic and lifestyle factors, current medication use, and medical history. Peripheral blood samples were collected for laboratory analysis.

Education was quantified based on the duration of formal schooling and categorised into two groups: elementary school or below, and above elementary school. The act of smoking was divided into two categories: individuals who currently smoke and those who have never smoked or used to smoke in the past.

Assessment of prediabetes, diabetes and normoglycaemia

Following the protocol established by the Diabetes Control and Complications Trial test, the Tosoh G7 automated high-performance liquid chromatography analyzer was used to assess the HbA1c levels in whole blood.

Statistical analysis
P < 0.05 was deemed statistically significant, and all analyses were done using SPSS 20.0.

3. RESULTS

Table 1: Patient Characteristics

Characteristics	**HbA1c category**		**FG category**	
	Normoglycemia (HbA1c <5.7%)	**Prediabetes (HbA1c 5.7%-6.4%)**	**Normoglycemia (FG <100 mg/dL)**	**Prediabetes (FG 100-125 mg/dL)**
N	150	100	100	150
<5.7%	150 (100)	0	68 (68)	75 (50)
5.7%-6.4%	0	100 (100)	36 (36)	75 (50)
FG				
<100 mg/dL	72 (48)	32 (32)	100 (100)	0
100-125 mg/dL	78 (52)	68 (68)	0	150 (100)
Age, mean (SD), y	75.1 (5.0)	75.5 (5.2)	75.4 (5.2)	75.2 (5.1)
Sex				
Male	66 (44)	43 (43)	35 (35)	72 (48)
Female	84 (56)	57 (57)	65 (65)	78 (52)

56.8% were females in the present study as compared to male. The mean age of the patients was 75 years.

Table 2: Performance of Different Definitions of Prediabetes in Older Adults for Identifying Incident Total Diabetes and Incident Diagnosed Diabetes

Prediabetes definition	Risk of total diabetes				Risk of diagnosed diabetes			
	Diagnostic performance for incident total diabetes, % (95% CI)							
	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Prediabetes (HbA1c) HbA1c 5.7%-6.4%	71.2 (63.4-78.1)	57.9 (55.0-59.9)	10.1 (55.9-59.9)	96.8 (95.7-97.6)	66.1 (56.8-74.6)	57.2 (55.1-59.2)	7.1 (5.7-8.8)	97.1 (96.1-98.0)
HbA1c <5.7% Prediabetes (IFG)	NA	NA	NA	NA	NA	NA	NA	NA
FG 100-125 mg/dL	80.1 (73.0-86.1)	42.9 (40.9-44.9)	8.5 (7.2-10.1)	97.0 (95.8-99.0)	77.1 (68.5-85.3)	42.4 (40.4-44.4)	6.2 (5.0-7.6)	97.4 (96.2-98.3)

FG <100 mg/dL Prediabetes (HbA1c or IFG)	NA	NA	NA	NA	NA	NA	NA	NA
HbA1c 5.7%-6.4% or FG 100-125 mg/dL	95.5 (91.0-98.2)	28.4 (26.6-30.3)	8.2 (6.9-9.5)	99.0 (97.9-99.6)	94.1 (88.2-97.6)	28.0 (26.2-29.8)	6.1 (5.0-7.3)	99.0 (97.9-99.6)
HbA1c 5.7%-6.4% and FG 100-125 mg/dL	55.8 (47.6-63.7)	72.4 (70.5-74.2)	11.9 (9.6-14.4)	96.1 (95.1-96.9)	49.2 (39.8-58.5)	68.7 (66.8-70.5)	7.9 (6.1-10.1)	96.6 (95.6-97.4)
HbA1c <5.7% or FG <100 mg/dL	NA	NA	NA	NA	NA	NA	NA	NA

The positive predictive values for the occurrence of complete diabetes, as measured by several prediabetes criteria, were consistently low, with values below 12%. In contrast, the negative predictive values regularly exceeded 96%. The most accurate method for identifying confirmed diabetes was through the detection of prediabetes using HbA1c levels of 5.7% to 6.4% or IFG (≥94%). The highest level of precision was achieved by detecting prediabetes using both HbA1c values of 5.7%-6.4% and IFG (confirmatory definition). The positive predictive values for incident diagnosed diabetes were constantly below 8%, whereas the negative predictive values were consistently high, at or above 97%. When several worldwide standards were used to define prediabetes, it was shown that the ability to accurately identify both newly occurring total diabetes cases and diagnosed diabetes cases was reduced to less than 48%. However, the ability to correctly exclude individuals without diabetes was improved to a level of 78% or higher.

4. DISCUSSION

The American Diabetes Association (ADA) has highlighted the notable dearth of research on the prognostic implications of elevated blood glucose levels in older adults.[13,14] There is a lack of adequate knowledge on the typical development of prediabetes in elderly individuals. The manifestation and outcomes of elevated blood glucose levels in elderly individuals exhibit variability in terms of their presentation and subsequent impact, hence influencing the therapeutic strategy.[14,15] However, there is a limited knowledge of how prediabetes progresses to diabetes in later age groups, and only a small number of studies[16,17] have examined the predictive outcomes of different definitions of prediabetes. There is a lack of consensus regarding the optimal definitions for prediabetes, and currently, five different definitions are being employed in clinical practice.[18,19] Understanding the typical development of prediabetes in older individuals has important consequences for the screening, diagnosis, and treatment of

the condition in this demographic. Prognostic data are essential for identifying the most efficient prediabetes definition(s), if any, for older populations.

In the present study, the female population constituted 56.8% of the total, while the male population was used for comparison. The mean age of the patients was 75 years. The positive predictive values for the occurrence of total diabetes, as determined by different definitions of prediabetes, consistently exhibited a low level, falling below 12%. In contrast, the negative predictive values regularly exhibited a substantial magnitude, reaching or above 96%.

Within this older population, a minority of individuals who met the criteria for prediabetes progressed to the state of diabetes. Prior studies[18,20-22] predominantly examined the progression from prediabetes to diabetes in middle-aged individuals. It is challenging to compare estimates of the progression of prediabetes because there are different definitions of prediabetes. A comprehensive review1 of 103 studies in mostly middle-aged individuals indicated that the 6-year cumulative incidence of diabetes was 17% (95% CI, 14%-20%) for those with prediabetes based on HbA1c values of 5.7% to 6.4% and was 22% (95% CI, 15%-31%) for those with IFG (FG, 100-125 mg/dL).

For diagnosing confirmed diabetes, sensitivity was again best for prediabetes based on HbA1c levels of 5.7% to 6.4% or IFG (≥94%), and specificity was highest for prediabetes based on both HbA1c levels of 5.7%-6.4% and IFG (confirmatory definition). The positive predictive values for incident diagnosed diabetes were all less than 8%, while the negative predictive values remained consistently high, at or above 97%. By employing alternative international definitions for prediabetes, the sensitivity for both incident total and diagnosed diabetes was found to be less than 48%, while the specificity was equal to or greater than 78%. While some participants in the study developed diabetes, a much larger number experienced a return to normal blood sugar levels, although the extent of this regression varied depending on the initial classification of prediabetes. There is more within-person variability for FG than for HbA1c, which probably explains why those with IFG values of 5.7% to 6.4% are more likely to have regression.[23] Adolescents and adults who are at risk of developing diabetes should be directed to a lifestyle programme that promotes regular physical exercise and weight loss (ideally, 7% of starting weight) if they meet any one of the following criteria: haemoglobin A1c levels between 5.7% and 6.4%, fasting glucose levels between 100 and 125 mg/dL, or 2-hour glucose levels between 140 and 199 mg/dL. Women with a history of gestational diabetes or patients younger than 60 years old with a body mass index (BMI) of 35 or higher (BMI is defined as weight in kilogrammes divided by height in metres squared) should take metformin.[24] The results of the present investigation endorse prioritising lifestyle enhancement when possible and secure, particularly considering the wider advantages of modifying one's lifestyle that extend beyond the prevention of diabetes.

5. CONCLUSION

Although the progression from prediabetes to diabetes was rare over a 6.5-year period, prediabetes was prevalent among older persons. The development of diabetes from prediabetes was less common than the regression to normoglycemia and mortality. These findings imply that prediabetes in older persons may not be a viable diagnostic category for predicting the onset of diabetes.

6. REFERENCES

1. Richter B, Hemmingsen B, Metzendorf MI, Takwoingi Y. Development of type 2 diabetes mellitus in people with intermediate hyperglycaemia. Cochrane Database of Systematic Reviews. 2018(10).

2. Care D. Classification and diagnosis of diabetes. Diabetes Care. 2017 Jan 1;40(Suppl 1):S11-24.
3. van Herpt TT, Ligthart S, Leening MJ, van Hoek M, Lieverse AG, Ikram MA, Sijbrands EJ, Dehghan A, Kavousi M. Lifetime risk to progress from pre-diabetes to type 2 diabetes among women and men: comparison between American Diabetes Association and World Health Organization diagnostic criteria. BMJ Open Diabetes Research and Care. 2020 Nov 1;8(2):e001529.
4. Ferrannini E. Definition of intervention points in prediabetes. The lancet Diabetes & endocrinology. 2014 Aug 1;2(8):667-75.
5. Bullard KM, Saydah SH, Imperatore G, Cowie CC, Gregg EW, Geiss LS, Cheng YJ, Rolka DB, Williams DE, Caspersen CJ. Secular changes in US prediabetes prevalence defined by hemoglobin A1c and fasting plasma glucose: National Health and Nutrition Examination Surveys, 1999–2010. Diabetes care. 2013 Aug 1;36(8):2286-93.
6. Tabák AG, Herder C, Rathmann W, Brunner EJ, Kivimäki M. Prediabetes: a high-risk state for diabetes development. The Lancet. 2012 Jun 16;379(9833):2279-90.
7. International Diabetes Federation. IDF Diabetes Atlas, 8th edn. Brussels, Belgium: International Diabetes Federation, 2017.
8. Rooney MR, Rawlings AM, Pankow JS, Tcheugui JB, Coresh J, Sharrett AR, Selvin E. Risk of progression to diabetes among older adults with prediabetes. JAMA internal medicine. 2021 Apr 1;181(4):511-9.
9. Feldman AL, Griffin SJ, Ahern AL, Long GH, Weinehall L, Fhärm E, Norberg M, Wennberg P. Impact of weight maintenance and loss on diabetes risk and burden: a population-based study in 33,184 participants. BMC Public Health. 2017 Dec;17(1):1-0.
10. McLean DL, Simpson SH, McAlister FA, Tsuyuki RT. Treatment and blood pressure control in 47,964 people with diabetes and hypertension: a systematic review of observational studies. Canadian Journal of Cardiology. 2006 Aug 1;22(10):855-60.
11. Pani LN, Korenda L, Meigs JB, Driver C, Chamany S, Fox CS, Sullivan L, D'Agostino RB, Nathan DM. Effect of aging on A1C levels in individuals without diabetes: evidence from the Framingham Offspring Study and the National Health and Nutrition Examination Survey 2001–2004. Diabetes care. 2008 Oct 1;31(10):1991-6.
12. Selvin E, Steffes MW, Zhu H, Matsushita K, Wagenknecht L, Pankow J, Coresh J, Brancati FL. Glycated hemoglobin, diabetes, and cardiovascular risk in nondiabetic adults. New England Journal of Medicine. 2010 Mar 4;362(9):800-11.
13. Sinclair A, Dunning T, Rodriguez-Mañas L. Diabetes in older people: new insights and remaining challenges. Lancet Diabetes Endocrinol. 2015 Apr;3(4):275-85.
14. Kirkman MS, Briscoe VJ, Clark N, Florez H, Haas LB, Halter JB, Huang ES, Korytkowski MT, Munshi MN, Odegard PS, Pratley RE, Swift CS. Diabetes in older adults. Diabetes Care. 2012 Dec;35(12):2650-64.
15. Halter JB, Musi N, McFarland Horne F, Crandall JP, Goldberg A, Harkless L, Hazzard WR, Huang ES, Kirkman MS, Plutzky J, Schmader KE, Zieman S, High KP. Diabetes and cardiovascular disease in older adults: current status and future directions. Diabetes. 2014 Aug;63(8):2578-89.
16. Shang Y, Marseglia A, Fratiglioni L, Welmer AK, Wang R, Wang HX, Xu W. Natural history of prediabetes in older adults from a population-based longitudinal study. J Intern Med. 2019 Sep;286(3):326-340.
17. Motta M, Bennati E, Cardillo E, Ferlito L, Malaguarnera M. The value of glycosylated hemoglobin (HbA1c) as a predictive risk factor in the diagnosis of diabetes mellitus (DM) in the elderly. Arch Gerontol Geriatr. 2010 Jan-Feb;50(1):60-4.
18. Warren B, Pankow JS, Matsushita K, Punjabi NM, Daya NR, Grams M, Woodward M, Selvin E. Comparative prognostic performance of definitions of prediabetes: a

prospective cohort analysis of the Atherosclerosis Risk in Communities (ARIC) study. Lancet Diabetes Endocrinol. 2017 Jan;5(1):34-42.
19. Echouffo-Tcheugui JB, Selvin E. Prediabetes and What It Means: The Epidemiological Evidence. Annu Rev Public Health. 2021 Apr 1;42:59-77.
20. Richter B, Hemmingsen B, Metzendorf MI, Takwoingi Y. Development of type 2 diabetes mellitus in people with intermediate hyperglycaemia. Cochrane Database Syst Rev. 2018 Oct 29;10(10):CD012661.
21. Schmidt MI, Bracco PA, Yudkin JS, Bensenor IM, Griep RH, Barreto SM, Castilhos CD, Duncan BB. Intermediate hyperglycaemia to predict progression to type 2 diabetes (ELSA-Brasil): an occupational cohort study in Brazil. Lancet Diabetes Endocrinol. 2019 Apr;7(4):267-277.
22. Ligthart S, van Herpt TT, Leening MJ, Kavousi M, Hofman A, Stricker BH, van Hoek M, Sijbrands EJ, Franco OH, Dehghan A. Lifetime risk of developing impaired glucose metabolism and eventual progression from prediabetes to type 2 diabetes: a prospective cohort study. Lancet Diabetes Endocrinol. 2016 Jan;4(1):44-51.
23. Selvin E, Crainiceanu CM, Brancati FL, Coresh J. Short-term variability in measures of glycemia and implications for the classification of diabetes. Arch Intern Med. 2007 Jul 23;167(14):1545-51.
24. American Diabetes Association. 3. Prevention or Delay of Type 2 Diabetes: Standards of Medical Care in Diabetes-2020. Diabetes Care. 2020 Jan;43(Suppl 1):S32-S36.
25. LeRoith D, Biessels GJ, Braithwaite SS, Casanueva FF, Draznin B, Halter JB, Hirsch IB, McDonnell ME, Molitch ME, Murad MH, Sinclair AJ. Treatment of Diabetes in Older Adults: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab. 2019 May 1;104(5):1520-1574.
26. Fang M, Echouffo-Tcheugui JB, Selvin E. Clinical and Public Health Implications of 2019 Endocrine Society Guidelines for Diagnosis of Diabetes in Older Adults. Diabetes Care. 2020 Jul;43(7):1456-1461.