

Original Article



Anthropometric Obesity Measures and Diabetes Progression from Prediabetes in Older Adults: A Comparison of American Diabetes Association and World Health Organization Criteria

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Abstract

Objective We examined the associations between obesity-related indices and the risk of diabetes progression from prediabetes in older adults, comparing the differences in using the American Diabetes Association (ADA) and World Health Organization (WHO) criteria.

Methods Data were obtained from the Healthy Aging Evaluation Longitudinal Study conducted in China. At baseline, prediabetes (in participants without diabetes) was classified based on fasting plasma glucose (FPG) levels using both criteria. Body mass index (BMI) and waist circumference (WC) were categorized according to data distribution and diagnostic cut-off values, respectively. Cox proportional hazards regression models were used to estimate the adjusted hazard ratios (*aHRs*) with 95% confidence intervals (*CIs*) for obesity-related indices and diabetes progression from prediabetes.

Results Among the 1,127 participants classified as prediabetic according to the ADA criteria, 474 met the WHO criteria. Under ADA-defined prediabetes, the highest WC quartile (≥ 93 cm) was significantly associated with an increased diabetes risk (*aHR* 1.93 [1.06, 3.53, $P < 0.05$]), whereas BMI-related and cut-off-based abdominal obesity demonstrated no significant associations ($P > 0.05$). Under WHO-defined prediabetes, both the high tertile of WC (≥ 90 cm) and general obesity (BMI ≥ 28.0 kg/m²) were significantly associated with progression to diabetes ($P < 0.05$), with *aHR* 2.13 (1.06, 4.27) and 2.44 (1.19, 5.01), respectively. However, cut-off-based abdominal obesity and the high BMI tertile (≥ 25.75 kg/m²) were not significantly associated with diabetes progression ($P > 0.05$).

Conclusion Elevated WC, rather than BMI-based indices or cut-off-based abdominal obesity, was significantly associated with diabetes progression according to the ADA-defined prediabetes criteria. However, both the evaluated WC and general obesity predicted progression to diabetes according to the WHO criteria.

Key words: Obesity; Diabetes progression; Prediabetes; ADA criteria; WHO criteria

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INTRODUCTION

Diabetes mellitus, which is associated with pathophysiological changes in several tissues and organs^[1,2], represents a significant global public health challenge, with a particularly high prevalence among older adults. Recent epidemiological studies have reported a global diabetes prevalence of 23.7% among adults aged ≥ 70 years^[3] and the prevalence exceeds 23.9% in China^[4]. Prediabetes, defined as an intermediate metabolic state between normal glucose tolerance and type 2 diabetes mellitus (T2DM), can be diagnosed using two major clinical criteria established by the American Diabetes Association (ADA) and World Health Organization (WHO). These criteria differ primarily in their threshold values for fasting glucose concentrations, 2-h plasma glucose levels during an oral glucose tolerance test, and glycated hemoglobin levels. Specifically, the ADA guidelines define impaired fasting glucose at a threshold of 5.6 mmol/L, whereas the WHO criterion is set at 6.1 mmol/L^[5,6]. This discrepancy in diagnostic thresholds has caused considerable variations in reported prediabetes prevalence across studies. Compared with the WHO guidelines, a lower cutoff under the ADA guidelines leads to a considerably higher prediabetes prevalence^[7,8].

Prediabetes represents a critical risk state for diabetes development; the transition from prediabetes to diabetes is a crucial clinical concern. However, the progression of hyperglycemia in older adults has been insufficiently studied^[9]. Metabolic progression is influenced by multiple factors, including obesity, lifestyle, and genetic polymorphisms^[10], among which obesity has been significantly implicated.

Body mass index (BMI) and waist circumference (WC) are fundamental anthropometric measures used to assess general and central obesity, respectively. A significant association exists between obesity and diabetes progression from prediabetes^[11]. Notably, anti-obesity pharmacological interventions have demonstrated promise in reducing the risk of progression to T2DM^[12]. However, inconsistencies persist regarding the specific roles of the different obesity measures. While certain studies indicate that general obesity, rather than abdominal obesity, significantly predicts diabetes risk in adults aged ≥ 40 years^[13], recent studies have demonstrated WC as a better predictor of T2DM development than BMI^[14].

Second, the relationship between these anthropometric measures and diabetes progression

may have been influenced by the diagnostic criteria used for prediabetes. Progression risk is lower in adults aged ≥ 45 years with ADA-defined prediabetes compared with WHO-defined prediabetes^[15]. However, a comprehensive comparative analysis of ADA and WHO criteria in relation to BMI and WC remains unexplored.

Third, most studies have focused on the general population, often neglecting the unique metabolic characteristics and health challenges faced by older adults. Longitudinal studies report that diabetes progression is relatively uncommon in older adults, with less than 12% progression from prediabetes to diabetes over 6.5 years, regardless of the diagnostic criteria^[6,16]. These findings suggest distinct risk factors for disease progression in older adults compared with younger populations.

To address these knowledge gaps, this community-based cohort study (1) assessed the associations of obesity-related indices with diabetes progression risk in older adults and (2) evaluated how ADA and WHO diagnostic criteria influence these associations.

METHODS

Study Participants

The study utilized data from the Healthy Aging Evaluation Longitudinal Study in China (HAELS), a community-based cohort study initiated in 2019 with follow-up in 2022^[17]. The study employed a multistage stratified probability-proportional-to-size sampling and random sampling method to recruit 4,690 older adults aged ≥ 65 years from six provinces/municipality/autonomous regions (Beijing, Shandong, Jilin, Jiangxi, Ningxia, and Guangxi), with 3,999 participants completing a 3-year follow-up. A field questionnaire survey and health examinations were conducted in six provinces, and blood biomarker levels were obtained from health records of the "Basic Public Health Service Project"^[18].

Assessment of Baseline Diabetes and Prediabetes Status

Baseline diabetes was defined as fasting plasma glucose (FPG) ≥ 7.0 mmol/L and/or self-reported diagnosis in hospital^[15]. Among the non-diabetic participants, prediabetes was classified according to the ADA criteria (FPG: 5.6–7.0 mmol/L). A subset meeting WHO criteria (FPG: 6.1–7.0 mmol/L) was further identified within the ADA-defined prediabetes group for comparative analysis.

Assessment of Obesity

Weight, height, and WC were measured twice using standardized protocols, and BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). General obesity was defined as $\text{BMI} \geq 28.0 \text{ kg}/\text{m}^2$, overweight as $24.0 \leq \text{BMI} < 28.0 \text{ kg}/\text{m}^2$, and normal/underweight as $\text{BMI} < 24.0 \text{ kg}/\text{m}^2$. Abdominal obesity was defined using WC cut-off values of $\geq 90 \text{ cm}$ for males and $\geq 85 \text{ cm}$ for females^[19].

For analytical purposes, BMI and WC were further stratified into quartiles based on their distributions among individuals with ADA-defined prediabetes. The quartile categories were as follows: for WC, $< 80 \text{ cm}$ (lower), ≥ 80 and $< 86.25 \text{ cm}$ (low), ≥ 86.25 and $< 93 \text{ cm}$ (high), and $\geq 93 \text{ cm}$ (higher); for BMI, $< 22 \text{ kg}/\text{m}^2$ (lower), ≥ 22 and $< 24.49 \text{ kg}/\text{m}^2$ (low), ≥ 24.49 and $< 26.72 \text{ kg}/\text{m}^2$ (high), and $\geq 26.72 \text{ kg}/\text{m}^2$ (higher).

We categorized BMI and WC on the basis of tertiles due to the relatively limited sample size in the WHO-defined prediabetes group: for WC, $< 81.5 \text{ cm}$ (low), ≥ 81.5 and $< 90 \text{ cm}$ (middle), and $\geq 90 \text{ cm}$ (high); for BMI, $< 22.67 \text{ kg}/\text{m}^2$ (low), ≥ 22.67 and $< 25.75 \text{ kg}/\text{m}^2$ (middle), and $> 25.75 \text{ kg}/\text{m}^2$ (high).

Diagnosis of Incident Type 2 Diabetes

We diagnosed T2DM based on FPG levels $\geq 7.0 \text{ mmol}/\text{L}$. The date of diabetes diagnosis was recorded as the event date. Participants who did not meet the diagnostic criteria for diabetes were censored on the date of their last FPG measurement, loss to follow-up, or death, whichever occurred first.

Covariates

Physical exercise was categorized as “yes” if a participant practiced exercise that increased the heart rate and respiratory rate, for example, running, swimming, bicycling, and square dancing, for at least 30 min per day, 3 days or more per week. Dietary intake was assessed using a validated food frequency questionnaire that evaluated the consumption patterns of 43 distinct food categories, including desserts and fried foods (for example, fried dough sticks and chips), over the preceding 12 months. For each food item or food group, the participants were first asked to report their consumption frequency, followed by a quantitative assessment of the portion size. The total dietary intake of each food item was calculated by multiplying the reported frequency of consumption by the average portion size^[20]. Dessert consumption was classified as “low intake” if the weekly consumption was less than 100 g, in accordance with established dietary guidelines.

Current smoking was defined as “yes” if the participant smokes “every day” or “non-daily,” and “No” if the participant is a lifelong non-smoker or ex-smoker. Alcohol consumption was defined as “yes” if the participant had ever drunk in the last 12 months. Hypertension was defined as a blood pressure level exceeding 140/90 mmHg or a self-reported diagnosis in the hospital^[19]. Blood biochemical indicators, including FPG, triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C), were collected from the health records of the “Basic Public Health Service”.

Statistical Analysis

Baseline characteristics were compared between ADA-defined prediabetes and WHO-defined prediabetes patients, classified according to FPG levels. We conducted *t*-tests for continuous variables and chi-square tests for categorical variables; for consumption frequency of fried foods with a skewed distribution, we calculated median values (M) and interquartile ranges (IQR) and compared them using Wilcoxon rank-sum nonparametric tests.

For the 3.6-year follow-up, we evaluated the cumulative incidence and incidence rates (per 1,000 person-years) of diabetes using the ADA and WHO criteria, respectively.

Cox proportional hazards regression models were used to estimate hazard ratios (HRs) with 95% confidence intervals (CIs) to assess the association between obesity-related indices and diabetes progression from prediabetes. Three models were adjusted: Model 1 was adjusted for age, sex, and education level; Model 2 was further adjusted for smoking, drinking, exercise, breakfast intake, and fried food consumption frequency; and Model 3 was further adjusted for hypertension, baseline glucose, TG, and HDL-C.

All analyses were performed using SAS, version 9.4 (SAS Institute Inc., Cary, NC, USA). $P < 0.05$ was considered statistically significant.

RESULTS

The baseline characteristics of the study participants are presented in [Table 1](#). Among the 4,690 participants at baseline, 1,264 were defined as prediabetes according to the ADA FPG criteria. Some cases with missing key variables, such as WC and body weight, were excluded and 1,127 prediabetic individuals were finally included in this study. Within this group, 474 participants simultaneously met the WHO FPG criteria for prediabetes, whereas the

remaining 653 subjects, classified as the non-WHO group, exhibited FPG levels ranging from 5.6 to 6.1. As shown in Table 1, the mean age of the participants was 72 years, and 55% were female, with baseline characteristics similar to those of the prediabetic groups defined by the ADA and WHO ($P > 0.05$), except for baseline FPG level. Among the 1,127 participants at baseline, 896 completed the follow-up survey.

As shown in Table 2 and Figure 1, among individuals with ADA-defined prediabetes, the overall diabetes incidence density was 31.23 (95% CI: 30.01–32.45) per 1,000 person-years. WC was significantly associated with an increased risk of diabetes progression ($P < 0.05$), with an adjusted HR of 1.02 (1.003–1.05), and further analysis revealed that this association was more significant in the male whereas not in the females, with HR of 1.04 (1.01–1.07) and 1.004 (0.97–1.03), respectively. The highest WC quartile (≥ 93 cm) demonstrated a significant association with increased diabetes progression risk ($P < 0.05$), with an adjusted HR of

1.93 (1.06–3.53). However, when abdominal obesity was defined using WC cut-off values, no significant association with disease progression was observed. Similarly, neither the highest BMI quartile (≥ 26.72 kg/m²) nor general obesity (BMI ≥ 28.0 kg/m²) was significantly associated with diabetes progression risk ($P > 0.05$).

As shown in Table 3 and Figure 1, among individuals with WHO-defined prediabetes, the overall diabetes incidence density was 43.96 per 1,000 person-years (95% CI: 41.38–46.54). The highest WC tertile (≥ 90 cm) demonstrated a significant association with diabetes progression from prediabetes ($P < 0.05$), yielding an adjusted HR of 2.13 (1.06–4.27). However, when abdominal obesity was defined using standard WC cut-off values, no significant association with disease progression was observed ($P > 0.05$). For BMI-related indices, general obesity (BMI ≥ 28.0 kg/m²), rather than the high BMI tertile (≥ 25.75 kg/m²), was significantly associated with diabetes progression, with adjusted HRs of 2.44 (1.19–5.01) and 1.88 (0.92–3.81), respectively.

Table 1. Baseline characteristics of participants by FPG level

Characteristics	ADA (FPG: 5.6–7.0 mmol/L)	Non-WHO (FPG: 5.6–6.1 mmol/L)	WHO (FPG: 6.1–7.0 mmol/L)	<i>P</i> -value*
Number of participants	1,127	653	474	
Age (years), mean (SD)	72.22 (5.87)	72.02 (5.70)	72.49 (6.10)	0.18
Female	616 (54.66)	366 (56.05)	250 (52.74)	0.27
Education (years)				
0	286 (25.38)	168 (25.73)	118 (24.89)	0.89
1–	488 (43.30)	279 (42.73)	209 (44.09)	
> 6	353 (31.32)	206 (31.55)	147 (31.01)	
Smoking	248 (22.01)	139 (21.29)	109 (23.00)	0.49
Drinking	275 (24.40)	147 (22.51)	128 (27.00)	0.08
Exercising	669 (59.36)	379 (58.04)	290 (61.18)	0.29
Low dessert intake	951 (84.38)	559 (85.60)	392 (82.70)	0.18
Consumption frequency of fried foods	0 (0, 0.23)	0 (0, 0.23)	0 (0, 0.47)	0.49
Hypertension	659 (58.47)	375 (57.43)	284 (59.92)	0.40
Waist circumference (cm)	86.55 (9.91)	86.88 (9.54)	86.09 (10.38)	0.19
BMI (kg/m ²)	24.52 (3.61)	24.61 (3.67)	24.40 (3.53)	0.34
FPG (mmol/L)	6.07 (0.36)	5.81 (0.14)	6.43 (0.26)	< 0.01
TG (mmol/L)	1.62 (1.08)	1.59 (1.01)	1.66 (1.17)	0.32
HDL-C (mmol/L)	1.48 (0.65)	1.47 (0.59)	1.50 (0.72)	0.33

Note. Data are shown as *n* (%) for categorical variables and mean (standard deviation) for continuous variables. The consumption frequency of fried foods was expressed as *M* (IQR). $P < 0.05$. *Comparison of baseline characteristics between the ADA and WHO criteria groups. BMI, body mass index; FPG, fasting plasma glucose; TG, triglyceride; HDL-C, high-density lipoprotein cholesterol.

DISCUSSION

To the best of our knowledge, this represents the first comprehensive investigation on the role of obesity measures in diabetes progression among older adults with prediabetes. Overall, in this longitudinal community-based cohort study, we found significant associations between obesity indices and diabetes progression risk in older adults with prediabetes, which was consistent with previous studies^[21,22], and these associations may vary according to the prediabetes criteria used, notably the initial FPG level at baseline. Furthermore, one study conducted in the US population demonstrated that the initial serum glucose level was an important predictor of diabetes progression from prediabetes^[22,23].

Specifically, we identified distinct association patterns depending on the diagnostic criteria

employed. Utilizing ADA criteria for prediabetes, we found that elevated WC (≥ 93 cm) demonstrated a positive association with diabetes progression, whereas neither cut-off-based abdominal obesity nor BMI-related indices showed significant associations. However, utilizing WHO criteria, we found that both elevated WC (≥ 90 cm) and general obesity (BMI ≥ 28.0 kg/m²) were significantly associated with diabetes progression, whereas cut-off-based abdominal obesity and the high BMI tertile (≥ 25.75 kg/m²) failed to demonstrate significant associations. These differential association patterns suggest that the predictive value of anthropometric indices may be influenced by both the specific measures employed and the diagnostic thresholds applied to define prediabetes.

Our findings, based on the ADA criteria, are consistent with those of previous studies demonstrating that WC is a stronger predictor of

Table 2. Association of obesity indices with progression of diabetes by ADA criteria ($n = 1,127$)

Variables	Events/participants	Incident density (95% CI)	HR (95% CI)		
			Model 1	Model 2	Model 3
WC (cm)			1.02 (1.002, 1.04)*	1.03 (1.01, 1.05)**	1.02 (1.003, 1.05)*
WC quartile					
Lower (< 80)	18/254	21.55 (20.78, 22.32)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Low (≥ 80 and < 86.25)	23/309	26.09 (24.10, 28.10)	1.11 (0.60, 2.07)	1.21 (0.65, 2.27)	1.17 (0.62, 2.22)
High (≥ 86.25 and < 93)	30/273	32.17 (31.13, 33.21)	1.46 (0.81, 2.64)	1.76 (0.97, 3.20)	1.57 (0.85, 2.88)
Higher (≥ 93)	36/291	42.55 (39.04, 46.06)	1.79 (1.01, 3.17)*	2.18 (1.22, 3.89)**	1.93 (1.06, 3.53)*
Abdominal obesity					
No	45/580	22.63 (22.27, 22.98)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	62/547	32.44 (31.33, 33.55)	1.32 (0.89, 1.96)	1.57 (1.04, 2.35)*	1.30 (0.85, 2.00)
BMI (kg/m ²)			1.06 (1.01, 1.12)*	1.06 (1.01, 1.11)*	1.04 (0.98, 1.10)
BMI quartile					
Lower (< 22)	18/282	20.43 (19.86, 21.00)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Low (≥ 22 and < 24.49)	27/282	26.09 (25.38, 26.81)	1.35 (0.74, 2.46)	1.41 (0.77, 2.58)	1.25 (0.68, 2.29)
High (≥ 24.49 and < 26.72)	30/281	30.12 (29.06, 31.18)	1.55 (0.86, 2.81)	1.73 (0.95, 3.41)	1.41 (0.76, 2.64)
Higher (≥ 26.72)	32/282	27.04 (25.83, 28.24)	1.71 (0.95, 3.07)	1.80 (0.99, 3.24)	1.47 (0.79, 2.71)
General obesity					
Normal/underweight	41/514	21.97 (21.54, 22.39)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Overweight	40/426	26.57 (25.71, 27.43)	1.15 (0.74, 1.78)	1.22 (0.78, 1.90)	1.02 (0.64, 1.63)
Obese	26/187	40.51 (38.92, 42.09)	1.83 (1.11, 3.00)*	1.82 (1.10, 3.00)*	1.52 (0.91, 2.54)

Note. Model 1 was adjusted for age, sex, and educational level; Model 2 was further adjusted for smoking, drinking, exercise, intake of desserts, and frequency of fried food consumption; and Model 3 was further adjusted for hypertension, baseline glucose, triglyceride, and high-density lipoprotein cholesterol. * $P < 0.05$, ** $P < 0.01$. ADA, American diabetes association; WC, waist circumference; BMI, body mass index; CI, confidence interval.

diabetes risk than BMI^[24,25], and the *OR* of progression to diabetes from prediabetes was also higher than BMI (2.50 vs. 1.98) in one African study^[26]. This can be explained by the role of insulin resistance, a key driver of T2DM. Insulin resistance is characterized by diminished insulin-stimulated glucose transport and metabolism in peripheral tissues coupled with

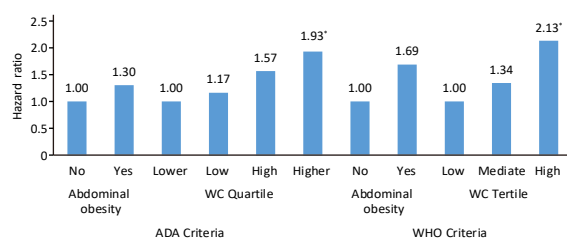


Figure 1. Hazard ratios of diabetes progression in prediabetic older adults by prediabetes criteria and WC categories. WC: waist circumference, ADA: American Diabetes Association, WHO: World Health Organization. * $P < 0.05$.

impaired suppression of hepatic glucose production^[27]. Although greater adiposity is generally correlated with insulin resistance, fat distribution is a critical factor. Intra-abdominal fat is more strongly linked to insulin resistance and T2DM than peripheral fat deposits^[28]. In the context of ADA-defined prediabetes, in which the baseline FPG levels and insulin resistance are relatively moderate, WC may be a more sensitive predictor of diabetes risk than BMI.

Applying the WHO criteria, which define prediabetes at higher baseline FPG levels, both higher WC > 90 cm and general obesity (BMI ≥ 28.0 kg/m²) were significantly associated with diabetes progression. These findings are consistent with those of previous studies that applied the WHO diagnostic criteria^[29]. Furthermore, the interaction between elevated baseline FPG levels and BMI during the development^[30] may explain why BMI has emerged as a significant predictor in this context.

An analysis of data using the ADA criteria revealed that the cut-off-based diagnosis of abdominal obesity failed to show a significant association with

Table 3. Association of obesity indices with progression of diabetes by WHO criterion ($n = 474$)

Variables	Events/participants	Incident density (95% CI)	HR (95% CI)		
			Model 1	Model 2	Model 3
WC (cm)			1.03 (1.01–1.06)*	1.04 (1.02–1.07)**	1.04 (1.01–1.07)**
WC quartile					
Low (< 81.5)	15/158	31.21 (29.66–32.75)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Mediate (≥ 81.5 and < 90)	19/152	36.80 (35.12–38.47)	1.20 (0.60–2.39)	1.41 (0.71, 2.83)	1.34 (0.65, 2.75)
High (≥ 90)	28/164	41.38 (39.58–43.18)	1.70 (0.89–3.26)	2.36 (1.21, 4.61)*	2.13 (1.06, 4.27)*
Abdominal obesity					
No	25/253	31.93 (30.97–32.90)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	37/221	38.72 (37.21–40.22)	1.46 (0.86–2.49)	1.88 (1.09, 3.24)*	1.69 (0.95–3.01)
BMI (kg/m ²)			1.08 (1.01–1.16)*	1.08 (1.01–1.16)*	1.08 (1.00–1.16)*
BMI tertile					
Low (< 22.67)	16/159	31.61 (30.09–33.13)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Mediate (≥ 22.67 and < 25.75)	18/156	37.98 (36.27–39.69)	1.09 (0.55–2.16)	1.18 (0.59–2.36)	1.06 (0.51–2.21)
High (≥ 25.75)	28/159	37.19 (34.40–39.98)	1.75 (0.93–3.31)	2.05 (1.07–3.94)*	1.88 (0.92–3.81)
General obesity					
Normal or underweight	22/224	31.69 (30.62–32.77)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Overweight	25/178	43.02 (40.78–45.25)	1.34 (0.75–2.38)	1.46 (0.81–2.64)	1.36 (0.73–2.55)
Obese	15/72	53.05 (48.42–57.69)	2.52 (1.27–5.02)**	2.56 (1.28–5.11)**	2.44 (1.19–5.01)*

Note. WC, waist circumference; BMI, body mass index; CI, confidence interval. Model 1 was adjusted for age, sex, and educational level; Model 2 was further adjusted for smoking, drinking, exercise, intake of desserts, and frequency of fried food consumption; and Model 3 was further adjusted for hypertension, baseline glucose, TG, and HDL-C. * $P < 0.05$, ** $P < 0.01$.

progression risk. This discrepancy may be attributed to the relatively conservative WC thresholds used in the cut-off-based diagnostic criteria compared with the higher WC cut-off in our study (≥ 93 cm). Similarly, under WHO criteria, neither the cut-off-based diagnosed abdominal obesity nor the high BMI tertile (≥ 25.75 kg/m²) demonstrated significant associations. We hypothesize that this observation may be explained by two factors: first, the mean WC in the guideline-based diagnosed group was substantially lower than our high WC group (≥ 90 cm); second, the BMI threshold for the high tertile (≥ 25.75 kg/m²) was considerably lower than the cut-off for general obesity (≥ 28.0 kg/m²). Thus, the cut-off-based obesity criteria in the current guidelines may not be optimal for assessing the risk of diabetes progression in prediabetic populations.

This study had several strengths. First, as a community-based 3.6-year prospective cohort study, it provided robust longitudinal data to elucidate the role of obesity-related indices in progression from prediabetes to diabetes. Second, our analytical approach incorporated both data-driven categorization (quartiles/tertiles) of BMI and WC, as well as standard guideline-based diagnostic criteria, allowing for a comprehensive evaluation of their association with progression risk. Third, the simultaneous application of the ADA and WHO diagnostic criteria for prediabetes offers valuable insights into the potential sources of variability across studies, thereby enhancing the generalizability and comparability of our findings.

However, this study had some limitations. First, prediabetes was defined solely by FPG level, which may limit the generalizability of our findings to other prediabetes definitions or diagnostic criteria. Second, this study is dependent solely on FBG values for the diagnosis of diabetes during follow-up, which may have underestimated its incidence and possibly affected the results. Third, because this study focused on older adults in China, further research is required to determine the applicability of these results to other demographic groups and populations.

In conclusion, our findings demonstrate that elevated WC, rather than BMI-related indices, is positively associated with progression from prediabetes to diabetes, as defined by the ADA criteria. However, both measures showed significant associations with diabetes progression when the WHO criteria of prediabetes were applied. These results demonstrate that WC is an earlier predictor of diabetes progression than BMI and that WC monitoring should be emphasized to assess the risk of

diabetes progression in older prediabetic individuals in the community, especially when the FPG level does not meet the WHO criteria for prediabetes.

Competing Interests The authors declare no conflict of interest.

Ethics The HAELS study was approved by the Ethics Committee of the Chinese Center for Disease Control and Prevention (reference number: 201936, 202212). Written informed consent was obtained from all participants (or their proxies).

Authors' Contributions Study design: Zhaoxue Yin; Data analysis: Xiujuan Zhang, Zhaoxue Yin; Manuscript writing: Xiujuan Zhang, Zhaoxue Yin; Study coordination and manuscript advice: Xiujuan Zhang, Huijie An, Virginia Byers Kraus, Xin Gao, Yunfan Li, Bowen Wang, Zhaoxue Yin. All authors participated in the critical revision and approval of the final manuscript.

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