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Prevalence and associated factors of prediabetes among primary health care attendees in the West bank of Palestine: a cross-sectional study

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Abstract

Background Prediabetes represents a major global health challenge with substantial implications for population health. This study aimed to determine the prevalence of prediabetes among attendees at Palestinian primary health care (PHC) centers and identify associated factors.

Methods A cross-sectional study was conducted in PHC centers in the West Bank from February to June 2024. A total of 635 participants, representing both sexes, were recruited from six PHC centers, two from each of the three main regions of the West Bank, including one central and one peripheral center per region. Prediabetes was diagnosed through HbA1c testing. Associated factors were assessed through face-to-face interviews using the validated Canadian Diabetes Risk Questionnaire (CANRISK).

Results The overall prevalence of prediabetes among PHC attendees was 13.7% (95% Confidence Interval (CI): 11.0–16.3%). Multivariable logistic regression analysis identified several factors significantly associated with prediabetes. These included central obesity (adjusted Odds Ratio (aOR) = 4.2; 95% CI: 1.3–13.9), male sex (aOR = 4.5; 95% CI: 2.1–9.7), older age (aOR = 24.1; 95% CI: 7.9–73.7), and a family history of diabetes (aOR = 4.3; 95% CI: 1.6–12.2). Additional significant variables included unemployment (aOR = 2.4; 95% CI: 1.15–4.9), physical inactivity (aOR = 2.1; 95% CI: 1.1–4.1), and irregular consumption of fruits and vegetables (aOR = 3.1; 95% CI: 1.9–5.7).

Conclusion The study reveals a significant prevalence of prediabetes among Palestinian PHC attendees, with central obesity, male sex, older age, and family history of diabetes emerging as key associated factors. We recommend that health policymakers integrate prediabetes detection into primary care, and clinicians prioritize lifestyle interventions for individuals at risk.

Keywords Prediabetes, Prevalence, Primary health care attendee, Risk factors, Screening, Palestine

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Introduction

Diabetes Mellitus (DM) is one of the four major non-communicable diseases (NCDs) that negatively affect all health-related quality-of-life domains [1]. In Palestine, DM ranks as the fourth leading cause of death, with prevalence expected to increase among adults [2, 3]. This rising prevalence underscores the importance of early detection [4, 5], particularly for identifying those at risk of developing DM, known as “prediabetes.”

Prediabetes is a condition characterized by elevated plasma glucose levels that are not high enough for a DM diagnosis [6]. It is assessed through fasting plasma glucose levels of 100–125 mg/dL, two-hour blood glucose levels of 140–199 mg/dL during an oral glucose tolerance test, or HbA1c levels of 5.7–6.4% [7]. In 2021, the global prevalence of impaired fasting glucose (IFG) among adults aged 20–79 was 5.8%, projected to rise to 6.5% by 2045 [8]. The 2022 Palestine STEPwise survey conducted by WHO indicated that 7.1% of 2,962 individuals in the West Bank had IFG [9].

Individuals with prediabetes are at heightened risk for developing diabetes and associated complications, including cardiovascular disease, chronic kidney disease, blindness, and increased all-cause mortality [10]. Early detection can mitigate these risks for individuals and society. The literature emphasizes that lifestyle interventions, such as dietary changes and physical activity, with or without medication, can significantly delay or prevent diabetes onset [11, 12]. Key prediabetes risk factors include race, age, obesity, family history of diabetes, sedentary behavior, high sugar intake, elevated blood pressure, and hypertriglyceridemia [10, 13–16].

The American Diabetes Association (ADA) recommends screening for prediabetes and type 2 diabetes (T2DM) in all adults starting at age 35. For individuals with additional risk factors, such as obesity, family history, hypertension, dyslipidemia, or physical inactivity, screening may be warranted at a younger age [7]. Various tools have been developed to help healthcare workers (HCWs) efficiently assess diabetes risk through noninvasive means. These tools use data commonly collected in primary healthcare (PHC) settings, such as age, gender, family history, hypertension, smoking status, physical activity, body mass index (BMI), and fruit and vegetable intake. The Canadian Diabetes Risk Questionnaire (CANRISK) is one example, designed to screen for both diabetes and prediabetes [17].

The West Bank, a territory under Israeli military occupation since 1967, has an estimated population of 3.2 million Palestinians, comprising both urban and rural populations, with approximately 15% living in refugee camps [18]. Within this context, PHC serves as the cornerstone of healthcare delivery, particularly for chronic disease prevention. Annually, Palestinian PHC centers

record over 2 million visits [19], representing a crucial yet underutilized opportunity for systematic prediabetes screening, a gap this study seeks to address. With the rising incidence of DM and its substantial public health implications, early detection is paramount. Consequently, this research aims to measure the prevalence of prediabetes and identify its associated risk factors among people attending Palestinian PHC center, utilizing HbA1c testing. Gaining a clear understanding of the extent and contributing factors of prediabetes will empower policymakers and HCWs to enhance awareness and implement targeted preventive strategies effectively.

Methodology

Study design and population

This cross-sectional observational study was conducted across PHC centers operated by the Palestinian Ministry of Health (MOH) in the West Bank between February and June 2024. The study setting comprised 608 MOH-affiliated PHC centers, each serving an average catchment population of 4,834 individuals according to the 2023 Palestinian annual health report [19]. These centers offer a comprehensive range of primary care services, including non-communicable disease screening, acute care management, immunization programs, and maternal-child health services.

The study population consisted of adults aged 18–74 years attending these PHC centers who met the following inclusion criteria: ability to provide informed consent, absence of communication barriers, and no prior DM diagnosis or hypoglycemic medication use. Exclusion criteria were applied to eliminate potential confounders, including pregnant women and individuals with cognitive or communicative impairments. Additionally, study participants without prior DM diagnosis who exhibited HbA1c levels meeting the diagnostic threshold for DM ($\geq 6.5\%$) were identified as having newly detected DM. These cases ($n=12$) were subsequently excluded from all analyses pertaining to prediabetes prevalence and its associated factors.

Sampling and sample size

The study employed a two-stage stratified sampling method to ensure geographic representation across the West Bank of Palestine, which comprises three distinct regions: North, Central, and South. In the first stage, we randomly selected one district from each region (North and Central) and two districts from the South region (given its larger size) using simple random sampling from comprehensive district lists. Jerusalem was excluded due to political and accessibility limitations. Within each selected district, we randomly chose one central and one PHC center, with peripheral centers selected from non-urban facilities offering laboratory services. The second

stage involved systematic random sampling within each PHC center: using patient registration logs, we selected every fifth attendee starting from the first registered patient. When selected individuals failed to meet inclusion criteria, we enrolled the next eligible attendee until the target sample size was reached. Recruitment numbers at each center were weighted according to patient flow volume and population coverage to maintain proportionality.

We calculated the required sample size using the formula for prevalence studies: $n = [DEFF \times Np(1-p)] / [(d^2 / Z_{1-\alpha/2}^2 \times (N-1)) + p(1-p)]$, where DEFF represents the design effect (set to 1 for random sampling), N is the target population size, p is the expected prevalence (50% based on preliminary data), d denotes the margin of error (0.04), and $Z_{1-\alpha/2}$ corresponds to the 95% confidence level ($Z=1.96$). Based on these parameters, the calculated sample size was 600, which is considered adequate to achieve the desired level of precision and ensure reliable estimates of prevalence and associated variables in the target population.

Study measures

The primary outcome of this study was prediabetes, determined by HbA1c levels: HbA1c < 5.7% was classified as normal, 5.7%–6.4% as prediabetes, and $\geq 6.5\%$ as DM [7]. HbA1c measurements were conducted using enzymatic assays on the Abbott ARCHITECT c4000 analyzer at all participating PHC centers. To ensure measurement accuracy and consistency, calibration procedures were performed according to the manufacturer's guidelines, and daily internal quality controls were routinely implemented. Blood samples were collected by certified laboratory technicians employed at the PHC centers, following a standardized protocol adopted across all PHC directorates.

Demographic and clinical information was collected using the Arabic version of the CANRISK tool. This tool underwent a validation process involving translation and cultural adaptation specifically for Arabic speakers, demonstrating strong reliability and validity within both Jordanian and Saudi population groups [20, 21]. Information gathered included age (grouped into four intervals), gender, height, weight, and BMI, categorized as follows: normal (< 25 kg/m²), overweight (≥ 25 to < 30 kg/m²), class I obesity (≥ 30 to < 35 kg/m²), and class II obesity (≥ 35 kg/m²) [22]. Researchers measured each participant's height without shoes using a portable measuring tape. Weight was recorded to the nearest 0.5 kg, while participants wore light clothing using a digital scale. Waist circumference (WC) was categorized based on central fat distribution as follows: normal fat distribution (male < 94 cm, female < 80 cm), moderate central fat accumulation (male 94–102 cm, female 80–88 cm), and high

central fat accumulation (male > 102 cm, female > 88 cm) [23]. WC was measured 2 cm above the navel with a portable measuring tape. The questionnaires were numbered and sorted accordingly once the data were confirmed as complete.

Lifestyle factors, such as physical activity (≥ 30 min of brisk walking daily) and self-reported fruit and vegetable consumption (consumption every day/not every day) intake, were assessed [24], as well as a history of hypertension or use of antihypertensive medication. Participants were asked about previous high blood glucose readings and, for females, any history of delivering large babies (> 4 kg). Family history of DM (father, mother, siblings, or children) and educational level (classified as secondary school or less, high school, college/university) were also recorded.

Data collection and ethical considerations

Data collection was conducted through structured face-to-face interviews following a standardized protocol. Prior to participation, all individuals received comprehensive information about the study aims and were assured of voluntary participation, data confidentiality, and their right to withdraw. Verbal consent was obtained from each participant. To maintain privacy, all interviews were conducted in private settings with only the researcher and participant present. The research team underwent training to standardize interview techniques and data collection and minimize potential biases. Data were recorded using secure paper-based forms with identical identifiers to electronic records to ensure traceability while maintaining confidentiality. The study adhered to the ethical principles of the Declaration of Helsinki and received approval from the Institutional Review Board at An-Najah National University (Reference #: Farm. Med. Dec. 2023/38). Additionally, formal permission to access and collect data within PHC centers was granted by the Palestinian MOH.

As part of the study protocol, participants' phone numbers were collected for follow-up communication regarding their HbA1c test results. Individuals with normal HbA1c values received reassurance and were advised to undergo re-screening every three years. Participants identified as prediabetic were encouraged to consult their PHC physicians and adopt evidence-based lifestyle modifications, including weight reduction, adherence to a healthy diet, and regular physical activity. The newly detected DM cases were referred to PHC physicians for further evaluation and clinical management, following ethical research practices and standard DM care protocols.

Table 1 Sociodemographic characteristics among the studied participants ($n = 635$)

Characters	Frequency	Percentage%
Gender		
Male	257	40.5
Female	378	59.5
Age (years)		
18–44	327	51.5
45–54	150	23.6
55–64	114	18.0
65–74	44	6.9
Residency place		
Urban	396	62.4
Rural	215	33.9
Refugee camp	24	3.8
Marital status		
Single	144	22.7
Married	446	70.2
Widowed/Divorced	45	7.1
Education		
Secondary school or less	214	33.7
High school degree	101	15.9
College or university degree	320	50.4
Employment		
Employed	302	47.6
Unemployed	291	45.8
Retired	42	6.6
Smoking Status		
Yes	249	39.2
No	386	60.8

Statistical analysis plan

Data entry and analysis were conducted using IBM SPSS Statistics for Windows, version 20. Descriptive statistics were used to summarize the data, including means, standard deviations, and ranges for continuous variables, as well as frequencies and percentages for categorical variables. Participants were stratified into two groups based on HbA1c levels: normal and prediabetic. For bivariate comparisons between groups, simple logistic regression was used to assess associations between the binary outcome (prediabetes status) and continuous independent variables, while the chi-square test was employed for categorical variables. To account for potential confounders and identify independent predictors of prediabetes, a multivariable binary logistic regression analysis was performed. Variables with $p < .05$ in bivariate analyses, along with clinically relevant variables from the literature, were included in the initial model. A backward elimination approach was applied, with results reported as adjusted odds ratios (aORs) and 95% confidence intervals (CIs). Statistical significance was set at a two-tailed α level of 0.05.

Table 2 Behavioral and clinical characteristics of the studied participants ($n = 635$)

Characters	Frequency	Percentage %
Physical activity		
Yes	232	36.5
No	403	63.5
Daily consumption of fruits/vegetables		
Everyday	428	67.4
Not everyday	207	32.6
History of hypertension		
Yes	179	28.2
No	456	71.8
History of high blood glucose readings		
Yes	56	8.8
No	579	91.2
History of delivery of a macrosomic child ($n = 378$)		
Yes	39	10.3
No	339	89.7
Family history of diabetes (<i>father, mother, siblings, children</i>)		
None of them	257	41.3
One of them	219	35.2
Two of them	114	18.3
Three of them	33	5.3
BMI		
< 25	162	25.5
25–29	199	31.3
30–34	148	23.3
≥ 35	126	19.8
Waist circumference		
Normal fat distribution	142	22.4
Moderate central fat accumulation	122	19.2
High central fat accumulation	371	58.4

Results

Out of 722 individuals approached and invited to participate from the various PHC centers, 635 consented to participate in our study, yielding a response rate of 88.3%. The majority of the participants were females (59.5%), with 51.5% falling within the 18–44 years' age group. Most participants (62.4%) resided in urban areas, and 70.2% were married. Educational attainment was high, with 50.4% having completed a college or university degree or higher. Additionally, 47.6% of participants were employed, and 39.2% reported being current smokers (Table 1).

The clinical history data indicated that 28.2% of participants had a diagnosis of hypertension, and 8.8% reported a history of elevated blood glucose levels. Additionally, 35.5% of participants had a family history of DM involving one immediate relative (e.g., father, mother, sibling, or child), while 23.6% reported two or more affected relatives. In terms of anthropometric characteristics, 42.3% of participants were classified as obese (BMI > 30 kg/m²), and 58.4% had WC exceeding 88 cm for females and 102 cm for males (Table 2).

The study identified a 13.7% prevalence of prediabetes (95% CI: 11.0, 16.3%) and 1.9% undiagnosed DM rate among PHC centers attendees based on ADA HbA1c criteria. Bivariable analysis demonstrated significant associations (all $p < .001$) between prediabetes and multiple associated factors: demographic characteristics (increasing age, married status, unemployment); clinical history (hypertension, previous hyperglycemia, family history of DM); lifestyle factors (physical inactivity, inadequate fruit and vegetable intake); and anthropometric measures (obesity [$\text{BMI} \geq 30 \text{ kg/m}^2$] and elevated central adiposity) (Table 3).

Logistic regression analysis revealed several predictors of prediabetes. Older age emerged as a strong factor, with older adults exhibiting a 24-fold increase in the odds of having prediabetes compared to younger individuals (aOR = 24.1; 95% CI: 7.9–73.7; $p \leq .001$). Males had 4.5 times higher odds of prediabetes than females (aOR = 4.5; 95% CI: 2.1–9.7; $p \leq .001$). Participants reporting a family history of DM in three or more relatives had 4.3 times higher odds of prediabetes (aOR = 4.3; 95% CI: 1.6–12.2; $p = .004$). Obesity was also a significant factor, with obese individuals having 3.4 times greater odds than those of normal weight (aOR = 3.4; 95% CI: 1.3–8.7; $p = .012$), while those with abdominal obesity had 4.2 times higher odds of prediabetes compared to those without (aOR = 4.2; 95% CI: 1.3–13.9; $p = .018$). Lifestyle factors also demonstrated notable associations. Physically inactive individuals had twice the odds of prediabetes compared to those who were active (aOR = 2.1; 95% CI: 1.1–4.1; $p = .030$), while those consuming inadequate amounts of fruits and vegetables had 3.1 times greater odds (aOR = 3.1; 95% CI: 1.9–5.7; $p \leq .001$). Additionally, unemployed participants showed 2.4 times higher odds of prediabetes compared to employed individuals (aOR = 2.4; 95% CI: 1.15–4.9; $p = .020$) (Table 3).

Discussion

The prevalence of prediabetes observed in our study was 13.7%. This figure is considerably higher than the 7.1% reported in the 2022 Palestinian national STEPwise survey [25]. This discrepancy may be attributed to differences in methodology, study populations, and diagnostic criteria. While our assessment relied on HbA1c levels, the STEPS survey used fasting glucose measurements. Moreover, our participant demographic differed in age distribution: we included adults aged 18–74, while the STEPS survey focused on individuals aged 18–65. Particularly, our study had a higher proportion of older participants (59% aged 40–75 vs. 51% aged 40–65 in the STEPS survey). Given that prediabetes risk increases with age, this difference in age structure likely contributed to the higher prevalence observed in our findings.

Another key factor is that our study focused on PHC attendees, who may represent a less healthy subset of the population compared to the broader community sampled in the STEPS survey. Regional lifestyle habits, including high-carbohydrate diets and low physical activity levels, may further exacerbate the prediabetes burden in Palestine. The 13.7% prevalence we observed is a serious concern, indicating a substantial risk of progression to T2DM and cardiovascular disease, potentially overwhelming healthcare resources if preventive measures are not prioritized.

On a global scale, reported prediabetes prevalence exhibits significant variation. For instance, the United States reported a prevalence of 34.5% in 2020 [26]. In contrast, estimates from the Eastern Mediterranean region tend to be lower, including 15.2% in Saudi Arabia, 17–17.5% in the United Arab Emirates [13], and an overall regional estimate of 12.7% from a meta-analysis by Mirahmadizadeh et al. [27]. These variations underscore the importance of diagnostic approaches and local factors, including diet and physical activity levels.

Consistent with established evidence [14, 26, 28, 29], our findings indicate that male sex and advancing age are strong predictors of prediabetes. Prevalence demonstrated a clear age-related increase, rising from 4.5% in the 18–44 age group to 39.5% among those aged 65–74 years. This highlights the need to focus screening and prevention efforts on older individuals in primary care, as they often face more health challenges. While men were more likely to have prediabetes in our study, possibly due to factors like body fat distribution or lifestyle [29]. It's worth noting that our sample had more women (59%) than the general population. This imbalance means we might be underestimating the true prevalence of prediabetes in the wider community.

Obesity is quite prevalent in Palestine [30]. In our study, over 43% of participants were classified as obese. Existing literature links both general and abdominal obesity to a greater odds of prediabetes [31, 32]. Our findings support this association, revealing significantly increased odds of prediabetes among individuals with abdominal obesity. This association was particularly evident in participants with abdominal obesity, aligning with evidence suggesting that abdominal obesity serves as a more robust predictor of prediabetes and T2DM compared to overall obesity [33, 34]. The underlying mechanism involves a strong correlation between the accumulation of visceral adipose tissue, insulin resistance, and β -cell dysfunction [35]. This makes WC a valuable predictive tool for PHC physicians to guide prediabetes screening and inform weight-loss intervention strategies. Nevertheless, routine WC assessment is not standard practice in PHC clinics, except for patients already diagnosed with non-communicable diseases.

Table 3 Bivariate and multivariate analysis of sociodemographic, behavioral, and clinical characteristics of participants with prediabetes ($n = 623$)

Variables	Prediabetes		P-value	Multivariate analysis	
	Yes ($n = 87$)	No ($n = 536$)		Adjusted OR (95% CI)	Adjusted P-value
Gender					
Male	42 (16.7)	210 (83.3)	0.109	4.5 (2.1–9.7)	≤ 0.001
Female*	45 (12.1)	326 (87.9)			
Age (years)					
18–44*	16 (4.9)	308 (95.1)			
45–54	22 (15)	125 (85)	≤ 0.001	2.9 (1.3–6.3)	0.009
55–64	32 (29.4)	77 (70.6)		7.9 (3.6–17.9)	≤ 0.001
65–74	17 (39.5)	26 (60.5)		24.1 (7.9–73.7)	≤ 0.001
Residency place					
Urban*	56 (14.4)	332 (85.6)	0.796		
Rural	27 (12.8)	184 (87.2)		1.1 (0.57–1.9)	0.852
Refugee camp	4 (16.7)	20 (83.3)		1.5 (0.34–6.3)	0.602
Marital status					
Single*	5 (3.5)	138 (96.5)			
Married	75 (17.2)	360 (82.8)	≤ 0.001	1.9 (0.64–5.4)	0.257
Widowed/Divorced	7 (15.6)	38 (84.4)		1.4 (0.35–5.9)	0.620
Education					
Secondary school or less*	38 (18.5)	167 (81.5)		1	
High school degree	16 (16.2)	83 (83.3)	0.024	1.2 (0.54–2.7)	0.646
Diploma or university degree	33 (22.6)	286 (77.4)		1.2 (0.61–2.4)	0.588
Employment					
Employed*	30 (10)	269 (90)	0.011	1	
Unemployed	47 (16.7)	235 (83.3)		2.4 (1.15–4.9)	0.020
Retired	10 (23.8)	32 (76.2)		0.79 (0.27–2.3)	0.675
Smoking Status					
Yes	34 (13.8)	212 (86.2)	0.933	1.3 (0.71–2.3)	0.413
No	53 (14.1)	324 (85.9)			
Physical activity					
Yes*	17 (7.4)	214 (92.6)	≤ 0.001	2.1 (1.1–4.1)	0.033
No	70 (17.9)	322 (82.1)			
Daily consumption of fruits/vegetables					
Everyday*	44 (10.4)	380 (89.6)	≤ 0.001	3.1 (1.9–5.7)	≤ 0.001
Not everyday	43 (21.6)	156 (78.4)			
History of hypertension					
Yes	42 (24.6)	129 (75.4)	≤ 0.001	1.1 (0.57–1.9)	0.928
No*	45 (10)	407 (90)			
History of high blood glucose readings					
Yes	17 (31.5)	37 (68.5)	≤ 0.001	4.6 (2.1–10.3)	≤ 0.001
No*	70 (12.3)	499 (87.7)		1	
History of delivery of a macrosomic child ^{oo}					
Yes	9 (23.7)	29 (76.3)	0.074	1.8 (0.72–4.8)	0.199
No	36 (10.8)	297 (89.2)			
Family history of diabetes (<i>father, mother, siblings, children</i>)					
None of them	29 (11.3)	228 (88.7)			
One of them	20 (9.1)	199 (90.9)	≤ 0.001	0.94 (0.46–1.9)	0.867
Two of them	27 (23.7)	87 (76.3)		2.8 (1.4–5.8)	0.005
Three of them	11 (33.3)	22 (66.7)		4.3 (1.6–12.2)	0.004
BMI					
< 25*	11 (6.8)	151 (93.2)		1	
25–29	17 (8.6)	180 (91.4)	≤ 0.001	0.84 (0.32–2.2)	0.710
30–34	28 (19.3)	117 (80.7)		2.1 (0.84–5.1)	0.114

Table 3 (continued)

Variables	Prediabetes		P-value	Multivariate analysis	
	Yes (n = 87)	No (n = 536)		Adjusted OR (95% CI)	Adjusted P-value
≥ 35	31 (26.1)	88 (73.9)		3.4 (1.3–8.7)	0.012
Waist circumference					
Normal fat distribution*	4 (2.8)	137 (97.2)			
Moderate central fat accumulation	16 (13.1)	106 (86.9)	≤ 0.001	3.4 (0.94– 11.9)	0.062
High central fat accumulation	67 (18.6)	293 (81.4)		4.2 (1.3–13.9)	0.018

*Reference group

**The percentages were calculated out of the total count of female participants

Concerning lifestyle factors, our results indicate a strong association between prediabetes and both physical inactivity and inadequate consumption of fruits and vegetables. Physical inactivity is recognized as a factor that promotes insulin resistance and weight gain. Conversely, regular physical activity enhances insulin sensitivity, lowers fasting blood glucose and HbA1c levels, and reduces both overall weight and visceral fat accumulation [36–38]. Furthermore, adherence to dietary patterns rich in fruits and vegetables, such as the Mediterranean diet, is associated with improved glycemic control and reduced odds of developing and progressing to prediabetes and T2DM [39]. Therefore, promoting and sustaining these healthy lifestyles behaviors are fundamental components of effective DM prevention strategies.

Family history represents one of the most significant non-modifiable associated factors for both DM and prediabetes, a finding consistently supported by existing literature [40]. Our findings reinforce this association, demonstrating 2–4 times greater odds of prediabetes among participants reporting two or more first-degree relatives diagnosed with DM. Identifying family history serves as a tool for targeting preventive interventions and motivating necessary behavioral modifications.

Our study identified unemployment as a significant factor, more than doubling the odds of prediabetes among affected participants. This finding aligns with previous research, including a meta-analysis showing a 1.6 times greater odds in unemployed populations [41]. This association likely stems from several interconnected factors. Unemployment often leads to financial instability and reduced access to healthcare, contributing to broader health disparities. It is also frequently associated with less healthy behaviors, such as decreased physical activity and suboptimal dietary patterns, which can contribute to obesity and insulin resistance [42]. Additionally, the chronic stress associated with unemployment may directly impair glucose metabolism and increase insulin resistance [43]. Within the specific Palestinian context, where prolonged political instability and occupation exacerbate socio-economic challenges and unemployment, public health strategies must prioritize targeted

screening, early intervention, and lifestyle support for unemployed individuals to mitigate the escalating burden of prediabetes.

A strong association was found between a prior history of elevated blood glucose (including during illness or pregnancy) and a significantly increased odds of prediabetes (nearly five-fold). This finding, particularly relevant given reports of high gestational diabetes rates among Palestinian women [44], underscores the critical need for diligent follow-up and intervention after any episode of hyperglycemia to prevent progression to T2DM.

Interestingly, we did not observe a statistically significant association between hypertension and prediabetes in our specific study group. However, it remains crucial to recognize that individuals with both conditions face heightened risks for cardiovascular complications and mortality [45]. Regarding other factors like smoking status, area of residence, and educational level, the existing research shows inconsistent association with prediabetes [46–49]. Our study reflects this variability; however, due to its cross-sectional nature, we cannot establish causal relationships between these variables.

Several limitations inherent in our study design warrant acknowledgment. Firstly, data on specific lifestyle behaviors, including fruit and vegetable intake and physical activity levels, were collected via self-report questionnaires. This methodology is susceptible to potential recall or social desirability bias. Secondly, the application of standard European cut-off values for BMI and WC might not be optimally suited for the specific anthropometric characteristics of the Palestinian population under investigation. Thirdly, our assessment did not encompass the full spectrum of potential prediabetes-associated factors, including comorbid health conditions, medication use, and serum lipid profiles. Lastly, the wide 95%CI intervals for some variables (e.g., age and abdominal obesity) suggest uncertainty in the precision of their estimates, possibly due to sample size limitations or data variability. While associations remain evident, caution is warranted in interpretation, and future studies with larger samples are encouraged to refine these estimates. Nevertheless, despite these limitations, the study possesses significant

strengths. To the best of our knowledge, this investigation represents the first effort to ascertain the prevalence of prediabetes and identify its associated factors specifically within the population utilizing PHC services.

Conclusion

This study found a significant prediabetes prevalence (13.7%) among adults attending PHC clinics in Palestine. Key associated factors identified were older age, male sex, family history of DM, obesity, inactivity, and poor diet. For healthcare managers and policymakers, these findings emphasize the importance of implementing routine PHC-based screening (particularly for high-risk groups), developing culturally appropriate lifestyle intervention programs, and strengthening HCW training in prediabetes management. The results also underscore the necessity of allocating resources for public health initiatives promoting physical activity and healthy eating, while supporting further research to evaluate intervention effectiveness and long-term outcomes.

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Authors' contributions

ZN and LS conceptualized the study, designed the methodology, oversaw data collection and analysis, contributed to manuscript writing, and provided overall supervision. LY, FH, and MA conducted data collection, performed the literature review, carried out data analysis, and contributed to drafting the manuscript. All authors reviewed, approved, and consented to the final version for journal submission.

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Data availability

The datasets generated and analyzed during this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The Institutional Review Board at An-Najah National University (Reference #: Farm. Med. Dec. 2023/38) granted ethical approval for this study, with additional permissions secured from the Palestinian Ministry of Health. All participants signed an informed consent form after being thoroughly briefed on the study's objectives and methodology before their involvement.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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