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Research Article

Prevalence of Undiagnosed Diabetes in 2004 and 2012: Evidence From the English Longitudinal Study of Aging

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Abstract

Background: In light of recent publicity campaigns to raise awareness of diabetes, we investigated changes in the prevalence of diabetes and undiagnosed diabetes in adults age 50 and older in England between 2004 and 2012, and explored risk factors for undiagnosed diabetes.
Method: In total, 7666 and 7729 individuals were from Wave 2 (2004–2005, mean age 66.6) and Wave 6 (2012–2013, mean age 67.6) of the English Longitudinal Study of Ageing. Diagnosed diabetes was defined as either self-reported diabetes or taking diabetic medications. Undiagnosed diabetes was defined as not self-reporting diabetes and not taking diabetic medications, but having a glycated hemoglobin measurement ≥48 mmol/mol (6.5%).
Results: There were increases in both diagnosed diabetes (7.7%–11.5%) and undiagnosed diabetes (2.4%–3.4%) between 2004 and 2012. However, a small decrease in the proportion of people with diabetes who were unaware of this condition (24.5%–23.1%, $p < .05$) was observed. Only men aged 50–74 showed a stable prevalence of undiagnosed diabetes, with better recognition of diabetes. Age, non-white ethnicity, manual social class, higher diastolic blood pressure, and cholesterol level were factors associated with higher risks of undiagnosed diabetes, whereas greater depressive symptoms were related to lower risks.
Conclusion: This study suggests that the greater awareness of diabetes in the population of England has not resulted in a decline in undiagnosed cases between 2004 and 2012. A greater focus on people from lower socioeconomic groups and those with cardiometabolic risk factors may help early diagnosis of diabetes for older adults.

Keywords: Diabetes unawareness, England, Prevalence, Risk factor

Diabetes is a common long-term condition for older people worldwide, including in the United Kingdom, where the prevalence of doctor-diagnosed diabetes among people aged 65 and older has risen from 5.6% in 1994 to 15% in 2017 (1). Diabetes is related to higher risks of all-cause and cause-specific mortality (2), while the economic burdens including health care and medical expenditures are substantial (3).

Undiagnosed type 2 diabetes is frequent because of the asymptomatic features of the condition at the initial stages (4). Diabetic complications, such as retinopathy, neuropathy, and atherosclerotic lesions, are common in people with newly diagnosed diabetes, indicating that complications may have developed in the early, undiagnosed phase of diabetes (4–6). When undiagnosed diabetes develops in older people, their health may be compromised (7,8); therefore, early diagnosis of diabetes is important, especially for older people who may have comorbidities (9,10). To address this issue, a range of screening tools and risk assessment protocols have been developed in many countries (11–14).

There has been an increase in public health information about the dangers of diabetes over recent years, with increased recognition of the links between unhealthy lifestyles and diabetes, campaigns to increase awareness, the introduction of an annual diabetes week in the United Kingdom, and implementation of screening tests in primary care (15–17). The NHS Health Check system that targets people aged 40–74 was launched in 2009 (17), and the system has been shown to detect more cases of diabetes, hypertension, and chronic kidney disease among attendees compared with non-attendees (18). It might therefore be expected that rates of undiagnosed diabetes would be reduced in England after this system was introduced.

Studies of undiagnosed diabetes among older people are scarce and have applied different definitions, with the reported prevalence from 0.9% to 13.2% (19–21). To date, no consensus on risk factors for undiagnosed diabetes in older people has been reached, although male sex, rural locality, a lack of private healthcare insurance, good self-rated health, higher body mass index (BMI), waist circumference, systolic blood pressure (SBP), triglycerides, and lower cholesterol level have been reported to relate to higher risk among older people (19–21). Furthermore, some factors such as age, ethnicity, and obesity have been associated with undiagnosed diabetes in adults in general, though not specifically among older people (22–24). Some differences in the prevalence and determinants of undiagnosed diabetes may be attributed to race, area, social background, diagnostic criteria for undiagnosed diabetes, and other factors (12,19–27).

The importance of early diagnosis of diabetes for older people is indisputable (9,10). To date, many studies have been based on adults across a wide age range or on non-representative samples (12,22–27), and subsequently limit the generalizability of the results. Little is known about whether the prevalence of and risk factors for undiagnosed diabetes in older people differ from that in younger adults. Also, the change in the prevalence of undiagnosed diabetes among older adults has not been explored over the last decade (19–21). Therefore, this study aimed to investigate the prevalence of both diabetes and undiagnosed diabetes between 2004 and 2012 in a nationally representative sample of older English adults, and to determine the potential risk factors for undiagnosed diabetes.

Methodology

Study Population

Data come from Wave 2 (2004–2005) and Wave 6 (2012–2013) of the English Longitudinal Study of Ageing (ELSA). ELSA is a nationally representative study of people aged 50 and older living in private households in England (28). Data collection is carried out using computer-assisted interviews every 2 years, and home visits from a study nurse every 4 years in which blood samples and other health-related measurements are taken (29,30). The ELSA sample is refreshed periodically with younger individuals to maintain the age profile of 50 and older. In the Wave 6 nurse visit, detailed medication profiles were collected for the first time, with study nurses recording information about all medications. The analytical samples for this study consist of 7666 individuals in Wave 2 and 7730 in Wave 6 who took part in the nurse assessments. Of these, 5816 of 7666 in Wave 2 and 5813 of 7730 in Wave 6 had valid glycated hemoglobin (HbA1c) measurements. We excluded 1 case of 7730 in Wave 6 because there was no information on diabetes diagnosis. Of the participants in Wave 6, 4330 (56.0%) had also participated in Wave 2, and the rest were new refreshment samples included in Waves 3, 4, and 6.

Main Outcome Variables

Diagnosed diabetes was defined as either self-reported doctor-diagnosed diabetes or taking diabetic medications (listed in Supplementary Table S1). Undiagnosed diabetes was defined as not having self-reported diabetes and any diabetic medications, but having an HbA1c measurement ≥48 mmol/mol (equivalent to 6.5% for the HbA1c measurement in 2004) (31). The information on medications, available in Wave 6 only, helps to verify the quality of self-reported diabetes in this study.

Risk Factors

Sociodemographic characteristics

Age (in years) was analyzed as a continuous variable. Education was classified into "no qualifications" and "some qualifications" (such as primary, secondary, and college and above). Ethnicity was coded as white and non-white. Cohabitation was defined as living with a partner. Wealth was used as the measure of economic resources, since it is more consistently associated with health outcomes at older ages than income (32). Wealth was computed from detailed assessments of housing wealth, savings, investments, and possessions net of debt (33,34). It was modeled as a continuous variable in the main analyses, but quintiles were presented for descriptive purposes. Occupational social class was defined according to current or most recent occupation and coded as professional-managerial or intermediate class, versus manual social class.

Health factors

Valid measurements obtained during nurse assessments for BMI, waist circumference, SBP, diastolic blood pressure (DBP), triglycerides, and total cholesterol were treated as potential risk factors in the analyses. Adiposity was categorized from BMI and waist circumference and classified into "normal BMI and waist circumference," "high BMI and waist circumference," and "either high BMI or waist circumference." High BMI was defined as BMI 30 and over. The cutoff values of waist circumference were 102 cm in males and 88 cm in females. Self-reported hypertension, cardiovascular disease (CVD), and hyperlipidemia were potentially related to diabetes so included in this study. Smoking status (ie, whether a current smoker or not) was also investigated. Depression was defined as having 4 or more depressive symptoms assessed by the 8-item version of the Center for Epidemiological Studies Depression Scale (CES-D) (35). Cognitive function was assessed by immediate and delayed recall memory tests. Participants were administered a list of 10 words orally, and then asked to recall as many words as possible. Recall was repeated after a 5-minute delay. Scores derived from memory scores ranged from 0 to 20.

Statistical Analysis

The percentage of unawareness among people with diabetes was calculated by dividing the proportion of undiagnosed diabetes by the total amount of diabetes (undiagnosed plus diagnosed). Multivariable logistic regression was used to determine the risk factors significantly associated with undiagnosed diabetes. The variables were entered into the model simultaneously and included age, sex, education, ethnicity, cohabitation, total wealth, social class, obesity, SBP, DBP, triglycerides, total cholesterol, smoking status, cognitive function, self-reported hypertension and CVD, and depression. Statistical analyses were conducted using Stata (version 15.1; StataCorp LP, College Station, TX).

Weighting

Inverse probability weighting was applied to adjust for sampling probabilities and differential non-responses in 2004 and 2012. Nurse weight was used for those who received nurse visits, and blood weight was used for those who also provided blood samples (29). The weighting is designed to render the results representative of English people aged 50 and older living in private households in 2004 (Wave 2) and 2012 (Wave 6).

Sensitivity analysis

Several sensitivity analyses were carried out. First, we analyzed the results using fasting glucose ≥7 mmol/L as the diagnostic criterion instead of HbA1c. Fasting glucose was only available for a subset of participants, so the sample size was reduced. Second, we repeated the analysis with a stricter threshold for undiagnosed diabetes (HbA1c ≥ 53 mmol/mol [7%]). Lastly, since 4330 participants in the sample were present at both waves, we computed the longitudinal changes in diabetes prevalence among the same individuals.

Results

Prevalence of Undiagnosed Diabetes in 2004 and 2012

The characteristics of the study samples in 2004 and 2012 are summarized in Table 1. The mean age was 66.6 years in 2004 and 67.6 years in 2012, and the gender distribution was similar between the 2 waves, with 55% of women and 45% of men. Of the participants in 2004, 37.4% did not have educational qualifications, while the proportion was 24.6% in 2012. There were similar distributions of other variables, except that the proportion of people with manual social class backgrounds was slightly higher in 2004 than in 2012.

There were 592 diagnosed and 115 undiagnosed (HbA1c ≥ 48 mmol/mol) cases in 2004, when no medications were collected. In 2012, only 890 participants reported having diabetes, but 930 diagnosed and 169 undiagnosed participants were identified after taking account of medications.

The overall prevalence of diagnosed and undiagnosed significantly increased from 2004 to 2012, with the exception of the proportion of people with diabetes who were unaware of the condition. After stratification by age and gender, men and women showed different changes in the prevalence of undiagnosed diabetes and proportion of unawareness among people with diabetes, depending on the age range.

The prevalence of diagnosed diabetes showed a noticeable increase from 7.7% in 2004 to 11.5% in 2012 (Table 2). More men were diagnosed with diabetes than women in both 2004 and 2012, and also in different age groups. As Table 3, the increase in the prevalence of diagnosed diabetes was greater among people aged 75+ than those aged 50–74. There was a significant rise in the prevalence of undiagnosed diabetes from 2.4% to 3.4% between 2004 and 2012; however, men aged 50–74 revealed an unchanged prevalence of undiagnosed diabetes over time (3.2% and 2.3%).

The overall proportion of people with diabetes who were unaware of the condition reduced slightly from 24.5% in 2004 to 23.1% in 2012; however, this masked important age and gender differences. Men with diabetes aged 50–74 were more aware of the condition in 2012 than 2004 (unawareness proportions: 17.3% vs 29.2%), while other diabetic people (older men and all women) were less aware of the condition in 2012, with the greatest increase in the proportion of unaware individuals among men aged 75+ (23.1%–35.9%).

Risk Factors for Undiagnosed Diabetes

The associations between potential risk factors and undiagnosed diabetes in 2012 are summarized in Table 4. The factors significantly related to a higher risk of undiagnosed diabetes were older age, non-white ethnicity, manual social class, higher DBP, and higher cholesterol level. By contrast, greater depressive symptoms were related to a lower risk. Risk for undiagnosed diabetes was not related to gender, ethnicity, education, wealth, obesity, smoking, or cognitive function.

Table 1. Cohort Characteristics in ELSA 2004 and 2012

Variables	2004 (*n* = 7666)	2012 (*n* = 7729)
Age (y), mean ± *SD*	66.6 ± 9.9	67.6 ± 9.5
Gender, % (*n*)		
Men	45.0 (3451)	44.6 (3447)
Women	55.0 (4215)	55.4 (4282)
Education, % (*n*)		
No qualifications	37.4 (2862)	24.6 (1893)
Some qualifications	62.6 (4801)	75.4 (5802)
Ethnicity, % (*n*)		
White	98.2 (7524)	96.9 (7493)
Non-white	1.8 (139)	3.1 (236)
Live with a partner, % (*n*)		
Yes	68.6 (5257)	67.9 (5250)
No	31.4 (2409)	32.1 (2479)
Total wealth, % (*n*)		
1 (lowest)	16.9 (1276)	20.2 (1464)
2	19.5 (1478)	19.9 (1440)
3	20.5 (1547)	20.1 (1457)
4	21.1 (1596)	20.0 (1449)
5 (highest)	22.0 (1666)	19.7 (1428)
Social class based on occupation, % (*n*)		
Professional-managerial or intermediate	56.7 (4282)	61.5 (4699)
Manual	43.3 (3268)	38.5 (2937)
Obesity, % (*n*)		
High BMI and waist circumference	27.7 (1969)	28.3 (2188)
High BMI or waist circumference	24.6 (1749)	22.4 (1734)
SBP (mm Hg), mean ± *SD*	135.3 ± 18.9	132.2 ± 17.5
DBP (mm Hg), mean ± *SD*	75.0 ± 11.2	73.5 ± 10.7
Triglyceride (mmol/L), mean ± *SD*	1.8 ± 1.2	1.5 ± 0.9
Cholesterol (mmol/L), mean ± *SD*	5.9 ± 1.2	5.5 ± 1.2
Current smoker, % (*n*)		
Yes	14.5 (1111)	11.5 (892)
No	85.5 (6535)	88.5 (6837)
Cognitive function, mean ± *SD*	9.96 ± 3.6	10.7 ± 3.6
Hypertension, % (*n*)		
Yes	43.6 (3341)	40.2 (3105)
No	56.4 (4325)	59.8 (4624)
CVD, % (*n*)		
Yes	25.7 (1972)	24.2 (1870)
No	74.3 (5694)	75.8 (5859)
Hyperlipidemia, % (*n*)		
Yes	–	38.8 (2995)
No	–	61.2 (4734)
CES-D scores, % (*n*)		
<4	85.0 (6451)	86.8 (6639)
≥4	15.0 (1136)	13.2 (1011)

Note: BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Scale; CVD = cardiovascular disease; DBP = diastolic blood pressure; SBP = systolic blood pressure.

Sensitivity Analyses

The analyses involving fasting glucose and a stricter threshold of HbA1c ≥53 mmol/mol (7%) were carried out to assess the robustness of our results and listed in Supplementary Tables S2–S5. As shown in Supplementary Tables S2 and S4, the 2 analyses both showed improved awareness among people with diabetes, as in the

main results. However, the prevalence of undiagnosed diabetes was relatively stable in the sensitivity analyses.

The results of the longitudinal change in diabetes prevalence among 4330 participants in the 2 waves are shown in Supplementary Tables S6 and S7. This cohort showed an increasing prevalence of diabetes over time, both diagnosed (6.2% in 2004 to 13.8% in 2012) and undiagnosed (1.9% in 2004 to 4.0% in 2012), but had a fairly stable proportion of people with diabetes who were unaware of the condition (23.8% in 2004 to 23.2% in 2012). The age- and gender-specific changes in diabetes prevalence and the percentages of unawareness were in line with the main findings.

Discussion

Using a nationally representative sample of older men and women in England, we found that the prevalence of diagnosed and undiagnosed increased between 2004 and 2012. There is an increasing prevalence of diagnosed diabetes over time among men and women in different age ranges. In general, men were more likely than women to have diagnosed diabetes. However, this was not the case for undiagnosed diabetes. Men aged 50–74 had a stable prevalence of undiagnosed diabetes, with a significant decline in the proportion of people with diabetes who were unaware of their condition. On the other hand, men aged 75+ and all women showed an increasing prevalence of undiagnosed diabetes, with the growing proportion of people who were unaware of the condition from 2004 to 2012.

The increase in diabetes prevalence was primarily due to the increase in diagnosed diabetes, and the impact of gender differences in undiagnosed diabetes was relatively small. The rising prevalence of undiagnosed diabetes among men was limited to adults aged 75+, while women had a significant increase in undiagnosed diabetes in both age groups. The robustness of our findings was largely confirmed in the sensitivity analyses, except that the prevalence of undiagnosed diabetes did not increase in the sensitivity analyses of fasting glucose and HbA1c of 7%. Due to many missing data in fasting glucose, the analysis had a reduced sample size that may influence the statistical power. For the analysis with a higher threshold of HbA1c, it is fair that fewer cases of undiagnosed diabetes were identified. At least, we confirmed that the prevalence of undiagnosed diabetes did not decrease between 2004 and 2012. Furthermore, the similar patterns of diabetes prevalence in the same cohort suggest that the increasing prevalence of diagnosed and undiagnosed diabetes may result from multiple factors rather than the ageing of the sample. Also, this cohort did not show a better awareness of diabetes, except for men aged 50–74 years, which was in line with the main findings, reassuring the reliability of the results from the longitudinal study.

Our findings to some extent confirm the impact of the NHS Health Check system that was established in 2009 and targets people aged 40–74. Men younger than 75 years had an unchanged prevalence of undiagnosed diabetes, whereas there was a rising rate among men aged 75 and older. However, the situation was different for women. During this period, the proportion of people with diabetes who were not aware of their condition was improved slightly, primarily because of greater awareness among men aged 50–74 years.

Comparison With Previous Research

The prevalence of undiagnosed diabetes among people aged 50 and older varies widely across studies from 0.9% in Ireland in 2009–2011 to 13.2% in Israel in 2009 (20,21). An earlier analysis of ELSA data from 2004 reported a prevalence of 1.7% compared with 2.4% in our study (19). The earlier study used a raised fasting glucose to identify diabetes, while our results were based on HbA1c. We were not able to use fasting glucose because of the large number of missing values and because we did not have information about the duration of fasting in Wave 6 (2012) of ELSA. Different criteria for undiagnosed diabetes will result in varying prevalence levels.

Risk factors

A wide range of risk factors for undiagnosed diabetes among older adults have been reported (19–21), but there is little agreement across studies. Our findings of older age, non-white ethnicity, and higher DBP are in line with previous studies that were not specifically focused on older people (22–24). However, the associations with risk factors we observed are different from those reported in the previous ELSA analysis (19). We found that higher cholesterol levels were related to undiagnosed diabetes, whereas lower cholesterols and higher triglyceride concentrations were identified as risk factors in the earlier study. The previous study used 8-hour fasting samples to define diabetes, and this may have influenced triglyceride estimates since triglycerides levels would be higher in the non-fasting state (36).

Undiagnosed diabetes was more common among men than women in 2 English studies (19,23), but this gender difference has not been observed in other work (20,21) or in this study. Other risk factors identified in previous studies of undiagnosed diabetes do not emerge in this study, including obesity. It should be noted that factors related to diagnosis are not fixed, but will vary with the vigor with which diabetes detection is pursued. It is possible that the growing recognition of diabetes risk among men, and its relationship with obesity, mean that these variables are no longer risk factors for undiagnosed diabetes. This explanation is endorsed by Table 3, since men aged 50–74 showed improvement in the awareness of diabetes.

Although diagnosed diabetes is well known to be associated with lower socioeconomic position (37,38), and with depression (38–40), relationships with undiagnosed diabetes have not previously been documented. Lower socioeconomic position may be related to less awareness of diabetes, while people with depressive symptoms may be more likely to have contact with health professionals leading to more frequent diagnosis.

Table 2. Prevalence of Diagnosed and Undiagnosed Diabetes, England 2004 and 2012

	2004		2012		Difference
	%	95% CI	%	95% CI	*p*
Diagnosed diabetes[a]	7.7	7.1, 8.4	11.5	10.7, 12.3	**<.001**
Undiagnosed diabetes	2.4	2.0, 2.9	3.4	2.8, 4.0	**<.001**
Unawareness among diabetic people	24.5	23.5, 25.5	23.1	22.2, 24.0	**.041**

Note: A *p*-value less than 0.05 is statistically significant.
[a]Weighted by non-response weight.

Table 3. Prevalence of Diagnosed and Undiagnosed Diabetes, by Age and Sex in England 2004 and 2012

	Age 50–74		Difference	Age 75+		Difference
	2004	2012	*p*	2004	2012	*p*
Men						
Diagnosed diabetes[a], %	8.3	11.1	**.001**	11.7	17.3	**.002**
95% CI	7.3, 9.4	9.9, 12.4		9.5, 14.3	14.7, 20.3	
Case (*n*)	234	340		84	141	
Undiagnosed diabetes, %	3.2	2.3	.063	3.2	7.9	**.001**
95% CI	2.5, 4.2	1.7, 3.2		1.9, 5.4	5.5, 11.3	
Case (*n*)	57	43		15	33	
Unawareness among diabetic people, %	29.2%	17.3%	**<.001**	23.1%	35.9%	**<.001**
95% CI	27.5, 30.9	15.9, 18.7		20.0, 26.2	32.6, 39.2	
Women						
Diagnosed diabetes[a], %	5.5	9.2	**<.001**	9.7	16.0	**<.001**
95% CI	4.7, 6.4	8.1, 10.6		8.0, 11.8	13.7, 18.5	
Case (*n*)	176	285		98	164	
Undiagnosed diabetes, %	1.5	3.0	**<.001**	2.2	4.9	**.007**
95% CI	1.0, 2.2	2.2, 4.0		1.2, 4.0	3.3, 7.4	
Case (*n*)	30	64		13	29	
Unawareness among diabetic people, %	21.8%	24.9%	**.003**	20.1%	25.0%	**.007**
95% CI	20.4, 23.2	23.4, 26.4		17.6, 22.6	22.4, 27.6	

Note: A *p*-value less than 0.05 is statistically significant.
[a]Weighted by non-response weight.

Table 4. Risk Factors for Undiagnosed Diabetes, England 2012

	Undiagnosed Diabetes (*n* = 588)		
	OR[a]	95% CI	*p*
Age (y)[b]	1.053	1.017, 1.090	**.004**
Female sex	1.385	0.837, 2.291	.205
No educational qualifications	1.002	0.577, 1.742	.994
Ethnicity non-white	3.397	1.398, 8.254	**.007**
Live with a partner	0.767	0.453, 1.298	.322
Total wealth[c]	1.055	0.869, 1.279	.590
Manual social class	1.981	1.205, 3.257	**.007**
Obesity			
High BMI and waist circumference	1.085	0.591, 1.992	.794
High BMI or waist circumference	0.865	0.444, 1.684	.670
SBP (mm Hg)[b]	0.985	0.968, 1.003	.101
DBP (mm Hg)[b]	1.077	1.045, 1.111	**<.001**
Triglyceride (mmol/L)[b]	0.811	0.649, 1.014	.067
Cholesterol (mmol/L)[b]	2.307	1.818, 2.926	**<.001**
Current smoker	1.428	0.636, 3.204	.388
Cognitive function[b]	0.989	0.920, 1.063	.763
Hypertension	0.665	0.409, 1.082	.100
CVD	1.625	0.970, 2.721	.065
Hyperlipidemia	0.656	0.411, 1.046	.077
CES-D scores ≥ 4	0.356	0.170, 0.745	**.006**

Notes: BMI = body mass index; CES-D = Center for Epidemiological Studies Depression Scale; CVD = cardiovascular disease; DBP = diastolic blood pressure; OR = odds ratio; SBP = systolic blood pressure.
[a]Unweighted odds ratio.
[b]Per 1 unit increase.
[c]From lowest quintile to richest quintile.

Undiagnosed Diabetes Based on HbA1c

HbA1c is a universal diagnostic tool for diabetes approved by the World Health Organization, and it can avoid day-to-day variability of plasma glucose levels and inconvenience of fasting or performing an oral glucose tolerance test (41). The convenience of HbA1c-based diagnosis, widely applied in the United Kingdom in 2011 (31), may contribute to more confirmed cases of diabetes, resulting in a higher prevalence of diabetes since 2011. Nevertheless, the steady increase rather than a surge in the prevalence of diagnosed diabetes across 2011, using published data from the Health Survey for England (Supplementary Table S8) (1), suggests that the adoption of HbA1c did not influence the prevalence greatly. Furthermore, the use of HbA1c raises some concerns since the ageing process involves increasing HbA1c values that may influence diabetes diagnosis in older people (6,31). HbA1c-based diagnosis has been proved to be modified by ethnicity and gender, and can show discrepancies with glucose-based diagnosis (6,42). However, the sensitivity analysis with fasting glucose showed similar prevalence levels, thereby helping to justify the use of HbA1c in this study.

Strengths and Limitations

The strengths of this study include the use of a nationally representative sample of older people from a population-based longitudinal study, the verification of self-reported health problems by objective assessments of medications, the inclusion of a comprehensive set of potential risk factors, the comparison of prevalence rates with 2 different measurements (HbA1c and fasting glucose), as well as the comparison of diabetes and undiagnosed diabetes with 2 different thresholds of HbA1c (6.5% and 7%). All analyses showed an increased prevalence of diagnosed diabetes and improved awareness of diabetes from 2004 to 2012. This suggests the results of this study are robust.

Some limitations to this research should be acknowledged. First, ELSA is a longitudinal ageing study, and participants receive feedback on their blood biomarkers. It is possible that individuals with high blood sugar levels in 2004 contacted their general practitioners and had diabetes diagnosed. If this was the case, it would be likely to decrease the prevalence of undiagnosed diabetes in 2012. Second, we applied a single HbA1c value, which might be imprecise, since at least 2 tests or symptoms are usually needed to make a diagnosis in

clinical practice (31,41). Lastly, recall bias cannot be avoided completely, even though self-reported diabetes was verified by the presence of diabetic medications.

From the clinical perspective, the most important inference is that notwithstanding the introduction of NHS Health Checks and public information campaigns to improve diabetes awareness in the population, undiagnosed diabetes has not declined. The overall levels of undiagnosed diabetes increased between 2004 and 2012 in line with the rising prevalence of diagnosed diabetes, except that men aged 50–74 showed a stable prevalence of undiagnosed diabetes with improved awareness of diabetes. Although the overall proportion of people with diabetes who were not diagnosed decreased slightly, this pattern was only strong among men aged 50–74. This suggests that men may be more easily to be identified than women through the NHS Health Check system.

Conclusion

This study confirms that diabetes rates are increasing in England, but also suggests that the greater awareness of diabetes in the population has not resulted in a decline in undiagnosed cases. Our analysis of risk factors suggests that greater focus on lower socioeconomic status individuals and on people with other cardiometabolic risk factors may help in the identification of diabetes at an earlier stage. It is hope that our findings may encourage the identification of undiagnosed diabetes for older adults in clinical practice.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None declared.

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