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Prevalence of diabetes and pre-diabetes in Bangladesh: a systematic review and meta-analysis

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ABSTRACT

Objective The purpose of this paper is to perform a systematic review and meta-analysis in order to summarise the prevalence of diabetes and pre-diabetes and their associated risk factors in Bangladesh.

Design Systematic review and meta-analysis.

Participants General population of Bangladesh.

Data sources PubMed, Medline, Embase, Bangladesh Journals Online, Science Direct, Scopus, Cochrane Library and Web of Science were used to search for studies, published between 1st of January 1995 and 31st of August 2019, on the prevalence of diabetes and pre-diabetes and their associated risk factors in Bangladesh. Only articles published in the English language articles were considered. Two authors independently selected studies. The quality of the articles was also assessed.

Results Out of 996 potentially relevant studies, 26 population-based studies, which together involved a total of 80 775 individuals, were included in the meta-analysis. The pooled prevalence of diabetes in the general population was 7.8% (95% CI: 6.4–9.3). In a sample of 56 452 individuals, the pooled prevalence of pre-diabetes was 10.1% (95% CI: 6.7–14.0; 17 studies). The univariable meta-regression analyses showed that the prevalence of diabetes is associated with the factors: the year of study, age of patients and presence of hypertension. The prevalence of diabetes was significantly higher in urban areas compared with rural areas, while there was no significant gender difference.

Conclusions This meta-analysis suggests a relatively high prevalence of pre-diabetes and diabetes in Bangladesh, with a significant difference between rural and urban areas. The main factors of diabetes include urbanisation, increasing age, hypertension and time period. Further research is needed to identify strategies for early detecting, prevention and treatment of people with diabetes in the population.

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Strengths and limitations of this study

- We used a comprehensive search strategy to identify all eligible studies and attempted to increase the quality and comparability of the included studies.
- Strong and reliable methodological and statistical methods were used.
- No publication bias was found in our analysis, which demonstrates that we did not miss any potential studies.
- Our analyses possessed a significant proportion of quantifiable heterogeneity.
- The common risk factors of diabetes and pre-diabetes were not sufficiently reported in many of the included studies.

INTRODUCTION

Diabetes is a major public health problem regionally and globally and is a leading cause of death in most countries.[1] In 2019, the International Diabetes Federation estimated that 465 million (9.3%) people worldwide had diabetes, and by 2045, the number may rise to 700 million (10.9%).[2] Similarly, the prevalence of pre-diabetes in adults was estimated to be 374 million (7.5%) people in 2019 and is predicted to increase to 548 million (8.6%) by 2045. The average life expectancy of patients with type 2 diabetes mellitus (T2DM) decreases by approximately 10 years, and 80% of patients with T2DM die from cardiovascular complications.[3] Furthermore, it was projected that between 2010 and 2030, there will be 69% more adults with diabetes in developing countries and 20% more in developed countries.[4] Around 79% of people with diabetes live in low-income or middle-income countries, and more than 60% live in Asian countries.[3] A progressive increase in the prevalence of diabetes and pre-diabetes has been observed both in urban and rural areas in South Asia, which is mostly due to lifestyle changes and the transition to urbanisation and industrialisation.[5–7] The rising rate of diabetes and its associated health complications threaten to reverse economic gains in developing countries.[8 9] Due to inadequate infrastructure for diabetes care, many developing countries will struggle to cope with this epidemic.[9]

Bangladesh is a developing country and is facing a continuous growth in the prevalence

of diabetes. According to the International Centre for Diarrhoeal Disease Research in Bangladesh in 2015, 7.1 million people had diabetes, 3.7 million cases were undiagnosed and about 129 000 deaths were attributed to the disease.[10] The prevalence of diabetes in Bangladesh, based on published studies, ranges from 2.21% to 35%.[11 12] However, the last meta-analysis was published in 2012, which converged studies published between 1995 and 2010.[13] Thus, a review is overdue to determine the prevalence of diabetes and pre-diabetes and their associated risk factors for the Bangladeshi population. The purpose of this systematic review and meta-analysis is to identify, select, summarise and estimate the pooled prevalence of diabetes and pre-diabetes and their associated risk factors in Bangladesh based on studies published between 1995 and 2019.

METHODS

Design and registration

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[14]

Literature search

A comprehensive literature search was conducted to identify studies, published between 1st of January 1995 and 31st of August 2019, on the prevalence of diabetes and pre-diabetes. Electronic searches were carried out systematically using the following databases: PubMed, Embase, Bangladesh Journals Online, Science Direct, Scopus, Cochrane Library and Web of Science. Using Medical Subject Headings, the following terms were searched for: 'type 2 diabetes', 'type-II diabetes', 'T2D', 'prevalence', 'impaired glucose tolerance', 'impaired fasting glucose', 'risk factors', 'risk factor', 'glucose intolerance', 'glucose abnormalities', 'Bangladeshi' and 'Bangladesh', as well as variations thereof. In addition, a snowball search method was used to search the reference lists of the included studies.

Inclusion and exclusion criteria

The inclusion criteria were as follows: the article (a) had sufficient data to estimate the prevalence of diabetes; (b) included a population-based or community-based survey and (c) was published in English. The exclusion criteria were as follows: the article (a) was irrelevant to diabetes; (b) was a review article; (c) was a case series or case report; (d) reported only on gestational diabetes; (e) was about a Bangladeshi community living outside of Bangladesh; (f) contained duplicate data (information) and (g) contained data that were published in more than one article (the most up-to-date version was considered).

Outcome measure

A number of diagnostic methods and criteria were used to measure the diabetes and pre-diabetes in the included studies in this review. Fasting blood glucose (FBG ≥7.0 or 6.1), 2-hour oral glucose (2hFBG ≥11.1) and glycated haemoglobin (≥6.5) were used individually or in combination of them as diabetes methods (criteria). Furthermore, 2hFBG, fasting plasma glucose (FPG), and FBG were considered individually or in combination of them as the diagnostic method of pre-diabetes and the diagnostic criteria were 2hFBG: 7.8–11.1, FPG: 6.1–6.9 or 5.6–6.0 and FBG: 7.8–11.1.

Data extraction

The review of eligible articles identified by the searches was completed by the two investigators (AS and RM) to identify studies to be reviewed in full text. Each full-text study was then reviewed for eligibility by these investigators, and for each included study, data were extracted independently using Microsoft Excel V.2013. Any disagreement on extracted data was resolved by mutual consensus or consultation. The following data points were collected: first author, year of publication, year of data collection, geographical region (division or city) where the study was conducted, number of participants, percentage of male participants, mean age of participants, percentage of participants with hypertension, percentage of smoker participants, percentage of obese or overweight participants and participants' family history of diabetes.

Methodological quality of the included studies

The two investigators independently assessed the methodological quality of each included study using the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.[15] Any disagreement on the quality assessment checklist was resolved by discussion or consultation with a third investigator (MAS). We categorised the quality of each included study as good (for quality scores above 69%), medium (for quality scores above 50%–69%) and poor (for scores below 50%).

Statistical analyses

All statistical analyses were performed using the software R V.3.6.1 (R Foundation for Statistical Computing, Vienna, Austria). Meta-analyses were performed with two packages: 'meta' and 'metafor'. We pooled the effect estimates, considering the DerSimonian-Laird inverse variance random-effects model, and presented the results in forest plots.[16] Random-effects models are more conservative than fixed effects models and have better properties in the presence of heterogeneity, as random-effect models take into account both within-study and between-study variances.[17–19] Freeman-Tukey double arcsine transformation was considered to stabilise the variance prior to the calculation of the pooled estimates.[20] Heterogeneity was tested by using the χ^2 test on Cochrane's Q statistic, which was calculated by using H and I^2 indices. The I^2 index estimates the percentage of total variation across studies based on true between-study differences rather than on chance. Conventionally, I^2 values of 0%–25% indicate low heterogeneity, 26%–75% indicate moderate heterogeneity and 76%–100% indicate substantial heterogeneity.[21]

We conducted subgroup analyses to find out the possible causes of substantial heterogeneity. Univariable meta-regression was used to test for an effect of study and participants' characteristics by adding covariates. The covariates were geographical location, year of publication, sample size, year of data collection, gender, methodological quality and mean age of participants. We evaluated the symmetry of the funnel plots and considered the Egger's regression test to examine for publication bias,[22] p<0.10 was considered to be statistically significant. Inter-rater agreement between the investigators, who were involved in study selection and data extraction, was assessed using Cohen's coefficient (κ).[23]

RESULT

Literature search

We initially identified 996 potential articles. After elimination of duplicates, 514 articles remained. We screened the titles and abstracts, and excluded 326 irrelevant articles. Agreement between authors on abstract selection was high (κ=0.896, p<0.001). We scrutinised the full texts of the remaining 53 papers for eligibility, 27 of which were excluded for the following reasons: nine studies did not mention the results of patients with diabetes, eight studies used the same datasets (which were duplicated for publication), three studies only assessed patients with type 1 diabetes and seven studies did not include enough information to estimate prevalence. Finally, only 26 studies met the inclusion criteria and data were extracted accordingly. The flow diagram of study selection is illustrated in figure 1; the PRISMA flow diagram[14] and the PRISMA checklist are provided in the online supplemental file S1.

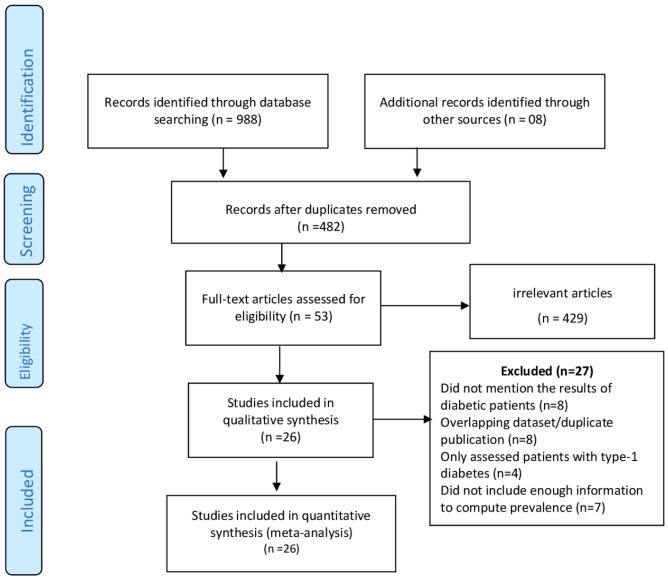

Figure 1 Flow diagram explaining the number of included and excluded articles in the meta-analysis on diabetes in Bangladesh, considered from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2009 guideline.

The characteristics of included studies

Table 1 shows the main characteristics of the included studies.[11 12 24–47] Nineteen out of the 26 studies used a cross-sectional research design, and 11 studies did not clearly specify a research design. The sample size of the included studies widely varied from 286[44] to 12 280 participants.[46] The articles were published between January 1995 and February 2019, while the period of participant inclusion was from July 1994[11] to March 2016.[46] All divisions of Bangladesh were represented in the selected articles: 13 studies were conducted in Dhaka,[11 12 24 29–32 34–36 39 43 44]2 studies in Khulna,[40 45] 2 studies in Mymensingh[25 27] 1 study in Ranpur,[38] 1 study in Chittagong,[28] 1 study in Barisal and Dhaka,[40] and 3 studies at the national level.[39 42 47] Furthermore, 11 studies were conducted in rural areas,[11 26 27 30–32 35 38 40 45 46]4 in urban areas,[12 24 33 44]7 studies in both settings[25 29 39 41–43 47]and 1 study in a suburban area.[34] The proportion of male participants ranged from 9% to 67% and the percentage of obese or overweight participants ranged from 5.7% to 47.2%. The average age of participants ranged from 31.3 to 51.48 years.[40] Twenty-three articles reported the gender of participants. After reviewing the quality of the studies, 16 were deemed to be of good quality, 10 of moderate quality and no article of poor quality. Agreement between authors on extracted data was high (κ=0.87, p<0.001).

The prevalence of diabetes and pre-diabetes in Bangladesh

The prevalence of diabetes is presented in table 2. The pooled prevalence of diabetes was 7.8% (95% CI: 6.4–9.3, I^2=99.3%, based on 26 articles) in a sample of 80 775 participants. The graphical display of the pooled prevalence of diabetes is presented in the forest plot (see figure 2). The funnel plot (see figure 3) and the Egger regression test (p=0.84) showed no publication bias in the included study. The forest plot presented in figure 4 showed that the pooled prevalence of pre-diabetes was 10.1% (95% CI: 6.7–14.0, I^2=99.5%, n=17), which was estimated from a total of 56 452 participants. The visual inspection of the funnel plot (see figure 5) showed no publication bias, which was confirmed by the Egger regression test (p=0.27).

Heterogeneity and subgroup analysis

The subgroup analysis is presented in table 2. The prevalence of diabetes in male participants (7.3%; 95% CI: 5.5–9.4) was slightly higher than female participants (6.70%; 95% CI: 5.0–8.7), but the difference was insignificant. The prevalence of diabetes in urban populations (11.5%; 95% CI: 7.4–16.4) was significantly higher (p=0.0157) than rural populations (6.2%; 95% CI: 4.6–7.9). The prevalence of diabetes in the age groups 20–30, 31–40, 41–50, and 50 and over were 2.8% (95% CI: 1.6–4.2), 6.5% (95% CI: 3.1–11.1), 9.3% (95% CI: 4.7–15.2) and 11.0% (95% CI: 5.7–17.7), respectively. The highest prevalence was observed in the 50 and over age group, and the overall prevalence increased with age.

Table 1 The characteristics of the included studies (n=26)

Author	Year	Year of data collection	Sample size	Positive	Prevalence	Average age of participant (years)	Research design	Setting	% of male	Division	Sampling	Diagnostic method and criteria for diabetes	Diagnostic method and criteria for pre-diabetes	% of hypertension	% of over-weight/ obese	% of smoker	% of family history	Quality
Sayeed *et al*[11]	1995	Jul–Nov 1994	1005	23	2.2	36.2	Unclear	Rural	44.8	Dhaka	Cluster sampling	FBG ≥7.0 and/or 2hFBG ≥11.1	7.8 ≤ 2hBG >11.1	NA	23.8	NA	NA	Good
Saquib *et al*[12]	2013	Unclear	402	142	35	49.4	Cross-sectional	Urban	49.7	Dhaka	Multistage random sampling	FBG ≥7.0 and/or HbA1C ≥6.5		NA	NA	31%	47.3	Medium
Sayeed *et al*[24]	1997	Jan–Sep 1996	8615	345	4.5	39.4	Unclear	Suburban	64.8	Dhaka	Unclear	FBG ≥7.0 and/or 2hBG ≥11.1	7.8 ≤ 2hBG >11.1	NA	9.54	NA	NA	Good
Sayeed *et al*[25]	1997	Unclear	2371	136	5.7	39.41	Unclear	Both	62.4	Mymensingh	Unclear	FBG ≥7.0 and/or 2hBG ≥11.1	7.8 ≤ 2hBG >11.1	NA	NA	NA	NA	Medium
Zaman *et al*[26]	2001	Unclear	515	13	2.5		Cross-sectional	Rural	NA		Unclear	FBG ≥7.0		12.9	7.2	28.1	NA	Medium
Sayeed *et al*[27]	2003	1999–2000	4923	212	4.3	31.3	Unclear	Rural	47.1	Mymensingh	Unclear	FPG ≥7.0	6.1 ≤ FPG ≥6.9	NA	NA	NA	NA	Good
Sayeed *et al*[28]	2004	Jun 2002	1119	68	6.6	39.7	Unclear	Unclear	41.9	Chittagong	Cluster random sampling	FPG ≥7.0	6.1 ≤ FPG ≥6.9	NA	NA	NA	NA	Good
Hussain *et al*[29]	2005	2004–2005	1555	126	8.1	33.5	Cross-sectional	Both	61.8	Dhaka	Simple random sampling	FBG ≥6.1		NA	5.7	NA	NA	Good
Hussain *et al*[30]	2006	1999	4757	108	2.3	37.5	Cross-sectional	Rural	42.8	Dhaka	Randomly	FBG ≥6.1	5.6≤ FPG ≥6.0	NA	6.1	NA	NA	Good
Rahim *et al*[31]	2007	2004	3981	271	6.8	37.4	Cross-sectional	Rural	31	Dhaka	Unclear	FBG ≥6.1 and/or 2hBG ≥11.1	5.6 ≤ FPG ≥6.0	NA	21.25	NA	NA	Medium
Rahman *et al*[32]	2007	Jan–Mar 2005	975	92	8.5	38.9	Cross-sectional	Rural	36.9	Dhaka	Unclear	FBG ≥6.1		NA	10.25	NA	NA	Good
Sayeed *et al*[33]	2007	Unclear	5265	590	11.2		Cross-sectional	Urban	NA		Two-stage cluster sampling	FBG ≥7.0 and/or 2hBG ≥11.1	5.6 ≤ FPG ≥6.0	NA	NA	NA	NA	Medium
Sayeed *et al*[34]	2008	Unclear	705	65	9.1	39.36	Unclear	Urban	34	Dhaka	Unclear	FBG ≥6.1	5.6 ≤ FPG ≥6.0	36.3	20.9	Na	NA	Medium
Rahim *et al*[35]	2010	Unclear	3387	279	8.2	36.8	Cross-sectional	Rural	40.8	Dhaka	Simple random sampling	FBG ≥6.1 and/or 2hBG ≥11.1	5.6 ≤ FPG ≥6.0 and/or 7.8 ≤ 2hBG >11.1	NA	9.47	NA	NA	Good
Das *et al*[36]	2010	Unclear	1200	54	4.5	NA	Cross-sectional	Unclear	NA	Dhaka	Unclear	Unclear		NA	17.3	NA	NA	Medium
Ahasan *et al*[37]	2011	Dec 2008	1000	99	9.9	40.58	Cross-sectional	Unclear	82.6	Unclear	Simple random sampling	FBG ≥7.0 and/or 2hBG ≥11.1	7.8 ≤ 2hBG >11.1	NA	47.2	20.6	NA	Medium
Akhter *et al*[38]	2011	Unclear	836	60	7.2	45.6	Cross-sectional	Rural	45.3	Rangpur	Multistage random sampling	FBG ≥7.0 and/or 2hBG ≥11.1 and/or HbA1c ≥6.5	7.8 ≤ 2hBG >11.1	NA	NA	NA	NA	Medium

Continued

Table 1 Continued

Author	Year	Year of data collection	Sample size	Positive	Prevalence	Average age of participant (years)	Research design	Setting	% of male	Division	Sampling	Diagnostic method and criteria for diabetes	Diagnostic method and criteria for pre-diabetes	% of hypertension	% of over-weight/ obese	% of smoker	% of family history	Quality
Akter *et al*[39]	2014	2011	7541	732	9.7	51.48	Cross-sectional	Both	50.6	National	Multistage cluster sampling	FBG ≥7.0	6.1 ≤ FPG ≥6.9	19.55	13.06	NA	NA	Good
Islam *et al*[40]	2015	Unclear	3095	222	7.2	51	Cross-sectional	Rural	34.5	Khulna	Multistage cluster sampling	FBG ≥7.0	6.1 ≤ FPG ≥6.9	33.8	32	42	8.35	Good
Alam *et al*[41]	2016	Mar and Oct 2009	1279	82	9.2	41.5	Cross-sectional	Both	NA	Dhaka, Barisal	Unclear	FBG ≥7.0 and/or 2hBG ≥11.1	5.6 ≤ FPG ≥6.9 and/or 7.8 ≤ 2hBG >11.1	NA	32.2	NA	NA	Medium
Sarker *et al*[42]	2016	Unclear	1910	245	12.8	39.9	Cross-sectional	Both	61.3	National	Unclear	FBG ≥7.0 and/or 2hBG ≥11.1	6.1 ≤ FPG ≥6.9 and/or 7.8 ≤ 2hBG >11.1	NA	12.3	NA	7.3	Good
Zaman *et al*[43]	2016	Unclear	2610	144	5.5	41.3	Unclear	Both	55	Dhaka	Multistage cluster sampling	FBG ≥7.0		15.1	9.0	NA	27.4	Medium
Asaduzzaman *et al*[44]	2018	Jul 2014–Jun 2015	286	29	10.1	NA	Cross-sectional	Urban	22.73	Dhaka	Unclear	FBG ≥7.0 and/or 2hBG ≥11.1	7.8 ≤ 2hBG >11.1	NA	Unclear	40.4	NA	Good
Hira *et al*[45]	2018	2012–2015	400	38	9.5	50.1	Cross-sectional	Rural	45.50	Khulna	Simple random sampling	FBG ≥7.0 and/or 2hBG ≥11.1	6.1 ≤ FPG ≥6.9 and/or 7.8 ≤ 2hBG >11.1	NA	NA	NA	NA	Medium
Fottrell *et al*[46]	2018	Jan–Mar 2016	12280	1249	11.4	46.6	Cross-sectional	Rural	46.2	Dhaka	Multistage random sampling	FBG ≥7.0 and/or 2hBG ≥11.1		22.6	34.6	31.8	NA	Good
Biswas *et al*[47]	2019	Jul and Dec 2011	8763	1052	12.0	NA	Cross-sectional	Both	51.13	National	Two-stage cluster sampling	FBG ≥7.0		28.6	21.6	NA	NA	Good

FBG ≥7.0 or 6.1; 2hFBG ≥11.1 and HbA1c ≥6.5.
2hFBG between 7.8 and 11.1; FPG 6.1–6.9 or 5.6–6.0; FBG 7.8–11.1.
FBG, fasting blood glucose; FPG, fasting plasma glucose; HbA1C, glycated haemoglobin; 2hFBG, 2-hour oral glucose; NA, not recorded or available.

Table 2 The prevalence of diabetes and pre-diabetes and its risk factors in the adult population of Bangladesh, from January 1995 to August 2019

Variable	Studies	Sample	Cases	Prevalence (%) (95% CI)	I^2 (%)	95%, prediction interval	P heterogeneity	P Egger	P difference
Pre-diabetes	17	56 452	7102	10.1 (6.7–13.0)	0.995	(0.2–31.7)	<0.001	0.2695	0.3214
Male pre-diabetes	13	26 020	3237	11.1 (7.8–14.9)	0.988	(1.1–29.5)	<0.001		
Female pre-diabetes	13	20 409	2820	11.7 (7.8–16.4)	0.987	(0.5–34.1)	<0.001		
Diabetes	26	80 775	6476	7.8 (6.4–9.3)	0.983	(1.8–17.3)	<0.001	0.8428	
Undiagnosed	4	6400	187	2.5 (1.2–4.2)	0.934	(0.0–80.1)	<0.001	0.3954	
By Sex								0.9379	0.4645
Male	16	27 004	2085	7.3 (5.5–9.4)	0.971	(1.6–18.4)	<0.001		
Female	16	25 584	1779	6.7 (5.0–8.7)	0.968	(0.9–18.6)	<0.001		
By setting								0.6305	0.0157
Rural	15	45 830	3326	6.2 (4.6– 7.9)	0.980	(1.1–14.9)	<0.001		
Urban	10	17 080	1588	11.5 (7.4–16.4)	0.988	(0.5–33.5)	<0.001		
By Age (years)								0.3765	0.0005
20–30	4	4871	124	2.8 (1.7–4.2)	0.944	(0.0–11.4)	0.0915		
31–40	5	3146	186	6.5 (3.1–11.1)	0.92	(0.0–28.9)	<0.001		
41–50	5	1731	133	9.3 (4.7–15.2)	0.935	(0.0–36.9)	<0.001		
51+	5	1919	185	11.0 (5.7–17.7)	0.847	(0.0–41.9)	<0.001		
Time period								0.8428	<0.001
1995–2000	3	11 991	504	4.0 (2.6–5.6)	0.917	(0.0–40.0)	<0.001		
2001–2010	11	23 382	1878	6.3 (4.4–8.5)	0.979	(0.8–16.4)	<0.001		
2011–2019	12	41 602	4094	10.4 (8.7–12.4)	0.968	(4.4–18.7)	<0.001		

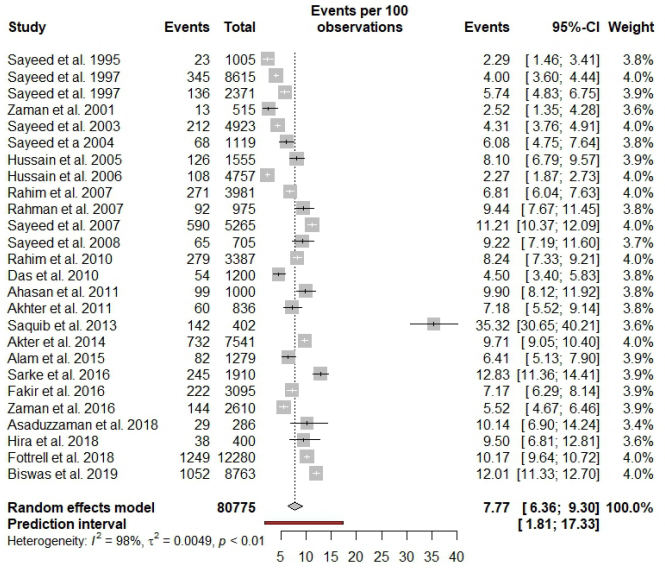

Figure 2 Forest plot of the prevalence of diabetes in the adult population of Bangladesh from January 1995 to August 2019.

The prevalence of diabetes stratified by publication periods: 1995–2000, 2001–2010 and 2011–2019. The prevalence of diabetes was 4.0% (95% CI: 2.6–5.6), 6.3% (95% CI: 4.4–8.5) and 10.4% (95% CI: 8.7–12.4), respectively for the publication periods. For over 24 years (1995–2019), the pooled prevalence of diabetes has significantly increased from 4.0% to 10.4%. There was no publication bias for all subgroup analyses.

The univariable meta-regression analyses (table 3) showed that the prevalence of diabetes increased with every year increase in age (β=0.008; 95% CI: 0.003–0.012, p<0.001; R^2=26.69%), year of publication (β=0.007 ; 95% CI: 0.004–0.009, p<0.0001; R^2=43.36%), date of data collection (β=0.008%; 95% CI: 0.005–0.011, p<0.0001; R^2=78.58%) and presence of hypertension (β=0.004; 95% CI: 0.000–0.008, p=0.099). The prevalence of diabetes was not associated with obesity or being overweight, gender, smoking status, methodological quality of articles, diagnostic method and diagnostic criteria of diabetes.

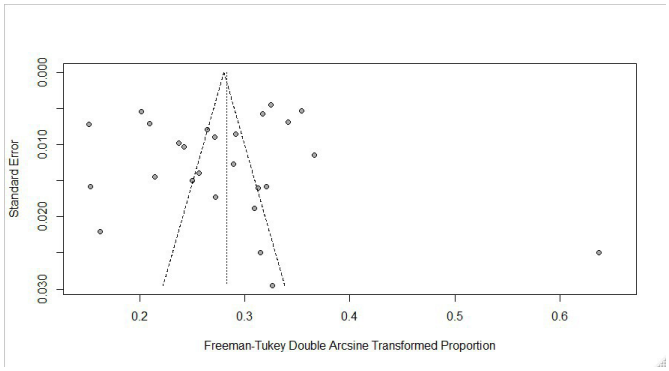

Figure 3 Funnel plot of the prevalence of diabetes in Bangladesh from January 1995 to August 2019.

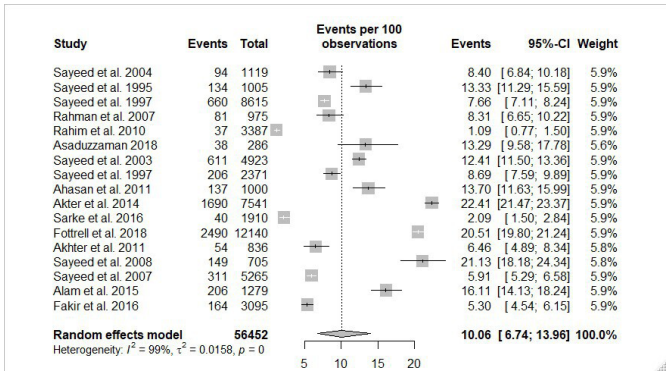

Figure 4 Forest plot of the prevalence of pre-diabetes in the adult population of Bangladesh from January 1995 to August 2019.

DISCUSSION

The main purpose of this systematic review was to compile all available data related to the prevalence of diabetes and pre-diabetes and their associated risk factors among adults in Bangladesh between 1995 and 2019. The information provided in this systematic review and meta-analysis will help to improve public health interventions to reduce the prevalence of diabetes. Twenty-six studies, based on 80 775 participants, were included in this study. The results showed that the pooled prevalence of diabetes was 7.8% and the pooled prevalence of pre-diabetes was 10.1%. By comparing results with other developing countries, the pooled prevalence of diabetes in Bangladesh was shown to be lower than in Nepal[48] (8.4%) and Pakistan[49] (14.7%), while being higher than in Cameroon[50] (5.8%) and China[51] (6.3%). On the other hand, the pooled prevalence of pre-diabetes in Bangladesh was shown to be higher than in Cameroon[50] (7.1%) and lower than in Pakistan[49] (11.43%) and Nepal[48] (10.3%).

The pooled prevalence of pre-diabetes in Bangladesh was shown to be slightly higher than diabetes. A possible reason may be that, because the Bangladeshi labour force has been shifting away from agricultural towards manufacturing services and industry, people's energy expenditure has significantly declined. The combination of increased

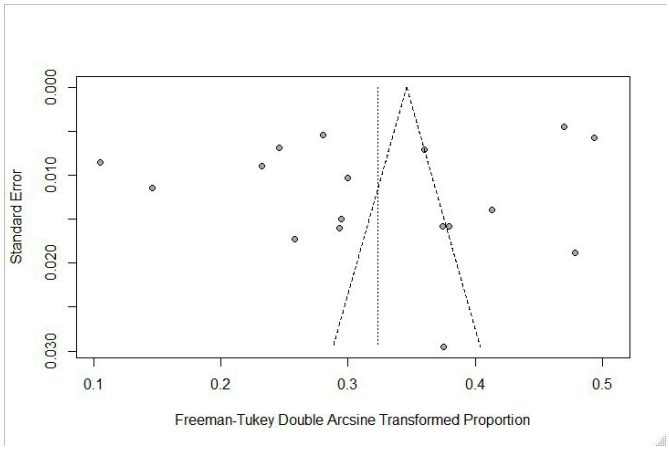

Figure 5 Funnel plot of the prevalence of pre-diabetes in Bangladesh from January 1995 to August 2019.

Table 3 Univariate meta-regression analysis

Variable	Beta (β)	P value	95% CI	R^2 (%)
Date of data collection	0.008	<0.001	0.005–0.011	75.78
Year of publication	0.007	<0.001	0.004–0.009	43.36
Age	0.008	<0.001	0.003–0.012	26.69
Hypertension	0.004	0.099	0.000–0.008	Nil
Methodology	−0.024	0.4121	−0.080–0.033	Nil
Overweight/obesity	0.017	0.1996	−0.001–0.004	15.14
Gender	0.001	0.8116	−0.002–0.003	Nil
Smoking	0.001	0.9134	−0.012–0.010	Nil
Diagnostic criteria	0.003	0.8786	−0.038–0.045	Nil
Diagnostic method	−0.021	0.2265	−0.055–0.013	1.37

energy intake and reduced energy output due to sedentary lifestyles leads to increased obesity and insulin resistance, which increases the risk of pre-diabetes.

The prevalence of diabetes according to this study is consistent with an earlier scoping review.[52] Urbanisation is ongoing in Bangladesh and has increased from 28.97% in 2008 to 36.63% in 2018. The pooled prevalence of diabetes in urban populations (11.5%) is significantly higher than rural populations (6.2%). A higher prevalence of diabetes in urban than rural areas is reported in most countries across the world.[53] Urbanisation is related to changes in eating habits, physical activity and exercise, smoking and alcohol consumption, which are risks factors for obesity and diabetes.[54] Our results also demonstrated that the pooled prevalence of diabetes was slightly higher among men than among women (7.34% compared with 6.70%). This result is consistent with previous literature.[55] On the other hand, there was no significant difference in the pooled prevalence of pre-diabetes between men and women. The prevalence of diabetes has increased 2.5 times over the last two decades from 4.0% in 1995–2000 to 10.4% in 2010–2019.

The systematic review and meta-analysis has several strengths as well as a few limitations. We used a comprehensive search strategy to identify all eligible studies and attempted to increase the quality and comparability of the included studies by using well-defined eligibility criteria. No publication bias was found in our analysis which demonstrates that we did not miss any potential studies that could have change the findings of this meta-analysis. Moreover, all included studies had a low risk of bias in their methodological quality. As shown by the meta-regression analyses, the overall methodological quality of the studies had an insignificant impact on the overall prevalence estimate. Furthermore, the included articles in this study cover all divisions of Bangladesh.

Our study has some potential limitations: First, a high heterogeneity was found between the included studies. However, we used subgroup analyses and meta-regression to cover the potential heterogeneity by adding covariates (ie, publication year, geographical area, sample size, proportion of male participants and study quality) to the bivariate model. Therefore, the estimates of this study should be interpreted with caution. Second, in this systematic review, we were unable to differentiate between the type 1 and type 2 diabetes; nonetheless, evidence shows that type 2 diabetes accounts for 90%–95% of all diabetes cases.[47] Third, we only considered univariable meta-regression analysis to test the significance of each covariate instead of multivariable meta-regression analyses. Multivariable meta-regression analyses might be a useful technique to take into account the variance due to diagnostic criteria for diabetes. However, the univariate analysis showed that the p values for both diagnostic method and diagnostic criteria are very high (method: p=22.65 and criteria: p=87.86). A variable with a high p value from univariate analysis is usually dropped out from the multivariable analysis. This is because of when the other variables in the model are adjusted for it, their effects remain almost the same as of their unadjusted effects. Furthermore, a limited number of studies in this review is also another potential barrier of performing multivariable meta-regression analysis.

Finally, being obese or overweight was found to be a statistically insignificant covariate of diabetes. This may be due to the limited number of studies in this systematic review and meta-analysis.

CONCLUSION

This systematic review and meta-analysis provides a comprehensive overview on the prevalence of diabetes and pre-diabetes in Bangladesh. In the absence of a national diabetes registry, the findings of this review provide an estimate of the prevalence of diabetes and pre-diabetes among the adult population in Bangladesh. Because of the high prevalence, we believe that a comprehensive national diabetes register is urgently needed in Bangladesh. Findings from this review revealed that the main drivers of diabetes are increased age, hypertension, urbanisation and time period.

As the prevalence of diabetes and pre-diabetes in Bangladesh is on the rise, the Bangladeshi government should set up diabetes control programmes all over the country. A policy intervention is a need of time to reduce the prevalence of diabetes in Bangladesh. In addition, Bangladeshi people should retain their traditional and more active lifestyles, which should include more physical activities and healthy food.

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