An updated systematic review and meta-analysis on the social determinants of diabetes and related risk factors in the Caribbean

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ABSTRACT

Objectives.   *To conduct an analysis of the most recent data on diabetes and its risk factors by gender and other social determinants of health to understand why its prevalence is higher among women than men in the Caribbean; to inform policy agenda-setting for diabetes prevention and control in the Caribbean; and to identify gaps in the evidence that require further research.*

Methods.   *A previous systematic review of the literature describing studies conducted in the Caribbean that presented the distribution of diabetes, its outcomes, and risk factors, by one or more social determinants, was updated to include sources from 1 January 2007 – 31 December 2016. Surveys by the World Health Organization (WHO) were also included. Where data were sufficient, meta-analyses were undertaken.*

Results.   *A total of 8 326 manuscripts were identified. Of those, 282 were selected for full text review, and 114, for abstraction. In all, 36 papers, including WHO-related surveys, had sufficient information for meta-analysis. More women compared to men were obese (OR: 2.1; 95%CI = 1.65 – 2.69), physically inactive (OR: 2.18; 95%CI = 1.75 – 2.72), and had diabetes (OR: 1.48; 95%CI = 1.25 – 1.76). More men smoked (OR: 4.27; 95%CI = 3.18 – 5.74) and had inadequate fruit and vegetable intake (OR: 1.37; 95%CI = 1.21 – 1.57)*

Conclusion.   *Thirty-six papers were added to the previously conducted systematic review; of those, 13 were added to the meta-analysis. Diabetes and its risk factors (primarily obesity and physical inactivity) continue to disproportionately affect women in the Caribbean. Smoking interventions should be targeted at men in this geographic area.*

Keywords   Diabetes mellitus; noncommunicable diseases; gender and health; obesity; risk factors; Caribbean region.

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Diabetes is a major cause of death and disability around the world and is projected to increase in the coming decades (1). Type 2 diabetes represents 80% – 90% of the total diabetes burden, with the main proximal risk factors being overweight and obesity, physical inactivity, unhealthy diet, and tobacco smoking (1). The prevalence of type 2 diabetes and its risk factors are strongly associated with underlying social and economic factors (2), with poorer, less educated people often being disproportionally affected. The World Health Organization

(WHO) has prioritized examining the social determinants of health in order to guide preventive interventions for several diseases, including diabetes and cardiovascular disease (3).

It has been reported that in the Caribbean, women may be at greater odds for diabetes (OR: 1.65; 95%CI = 1.43 – 1.91) and obesity (OR: 3.10; 95%CI = 2.43 – 3.94) than men (4). Sobers-Grannum and colleagues examined the effects of gender on diabetes, its risk factors, and outcomes in the Caribbean in a systematic review published in 2015 (4). In addition to gender, the review sought to describe data on a range of social determinants of health, but evidence was scant, making it impossible to provide even a narrative review of the relationship of outcomes to other social determinants.

Guided by the analytical framework recommended by the WHO Commission on the Social Determinants of Health (3), the present study updates the previous systematic review (4) with new data, including new information on physical activity, a wider range of social determinants, and sources from the grey literature. The objective of this review was to inform policy agenda-setting for diabetes prevention and control in the Caribbean, and to identify gaps in the evidence where further research is needed.

MATERIALS AND METHODS

This was a systematic review of diabetes distribution, risk factors, and outcomes, by social determinants of health, in the Caribbean. The study protocol for this review followed that of Sobers-Grannum and colleagues (4) and added newer data collected from NCD survey reports available on the websites of the Pan American Health Organization (PAHO) and WHO. In short, using the same search strategies as the original (4), this review included data for three additional years (2014 – 2016), extending the collection from 1 January 2007 – 31 December 2016. A search was conducted for studies in the Caribbean—its countries and territories as defined by Samuels and colleagues (5)—that reported on diabetes distribution, risk factors, and outcomes, by one or more social determinant(s). Guided by the Progress-plus checklist (6), the social determinants examined were: gender; marital status; income; housing; urban/rural location;

education; ethnicity; and owning household assets.

Diabetes outcomes and risk factors were considered among both the general population and those with diabetes. For the general population, the review looked at: obesity, including measures of body mass index (BMI), waist circumference (WC), and abdominal obesity; physical inactivity; tobacco use; measures of diet quality, e.g., consumption of fruits and vegetables, diet quality scores, etc.; and type 1 and type 2 diabetes prevalence and incidence. Among those with diabetes, the review considered: control measures, including glucose, glycated hemoglobin, blood pressure, and lipids; measures of incidence or prevalence of retinopathy, nephropathy, neuropathy, diabetic foot, and lower extremity amputation; and mortality.

Search criteria were deliberately kept broad so as to capture any relationship related to diabetes and one of the social determinants. Studies included had:

- Caribbean study population
- Adult participants (≥ 18 years of age) when considering diabetes and its outcomes, or participants ≥ 12 years when considering risk factors
- Outcomes stratified by at least one of the social determinants
- Quantitative study design (observational/intervention)
- Sample size ≥ 50 people

Excluded studies had:

- Diaspora study population or other non-Caribbean
- Narrative review design, commentary, case series, qualitative study, or single case report

A systematic search was conducted of PubMed Central (U.S. National Library of Medicine, Bethesda, Maryland, United States); EMBASE (Excerpta Medica Database, Elsevier, Amsterdam, the Netherlands); the Virtual Health Library, including LILACS (Latin American and Caribbean Center on Health Sciences Information, PAHO/WHO, São Paolo, Brazil; BIREME); MedCarib (Health sciences data from the English speaking Caribbean; BIREME); and IBECS (Biographic Index on Health Sciences; BIREME). Reports from the WHO STEP-wise approach to noncommunicable disease risk factor surveillance surveys (STEPS; 7) and other nationally representative NCD reports were identified from PAHO (8)

and WHO (9) websites. Studies were included if the complete text was available; if not, they were excluded. There were no limits regarding the language of publication.

Bibliographic information for each study was entered into the Rayyan online data system (Qatar Computing Research Institute, Doha, Qatar; 10). Titles and abstracts were independently reviewed by two reviewers (LG and CB); conflicts were resolved by a third reviewer (NS). The full text of all retained articles was sought, and where available, was independently abstracted by two reviewers (LG and CB); again, any differences were resolved in discussion with a third reviewer (NS). Analysis was conducted at the relationship level between individual social determinants and outcomes, since several relationships could exist within a single study.

A form for data abstraction was designed using OpenOffice™ Base (Oracle Corporation, Santa Clara, California, United States). The form was guided by the STROBE statement (11) for reporting observational epidemiology and by the PRISMA statement on systematic reviews concerning health equality (12). The PRISMA statement was also consulted for reporting results (13).

Risk of bias was assessed using criteria applied by Brown and colleagues (14) for each relationship and classified as follows:

1. Low risk of bias (all criteria are met)—response rate > 75%, missing data < 10%, full description of sampling strategy, adjustment of measures by age and other potential confounders (such as sex or ethnicity), as appropriate, and objective measurement of disease measures;
2. Medium risk of bias (one or more criterion)—response rate 50% – 75%, missing data 10% – 15%, adjustment of measures by age and other potential confounders (such as sex or ethnicity), as appropriate, and subjective measurement of disease measures;
3. High risk of bias (one or more criterion)—response rate ≤ 50%, missing data > 15%, inappropriate adjustment for confounders (i.e., missing important adjustment or no adjustment), poor sampling strategy, inappropriate assessment of the disease measure;
4. Unclear—not enough information to make an assessment.

Only population-based, cross-sectional studies that measured the outcomes as dichotomous variables were included for meta-analysis. Meta-analyses were conducted and random effects models were fitted, including I-squared values for obesity and gender (heterogeneity, I^2 = 96%), physical inactivity and gender (I^2 = 94.4%), insufficient fruit and vegetable intake and gender (I^2 = 94.4%), smoking/tobacco use and gender (I^2 = 94.7%), and diabetes prevalence and gender (I^2 = 88.1%). Other social determinants were too heterogeneously defined to allow for meta-analysis; these were described narratively.

Only subjectively measured physical inactivity estimates were available. Physical inactivity was defined dichotomously where subjects reported either no physical activity or physical activity below WHO-recommended levels (15).

RESULTS

The selection process is summarized in Figure 1. The 69 studies and reports, including nine PAHO and WHO sources with full reports available, yielded 374 relationships with the following social determinants: education (n = 33), employment (n = 14), ethnicity (n = 26), gender (n = 267), household assets (n = 1), housing type (n = 3), income (n = 10), insurance status (n = 4), urban/rural setting (n = 9), marital status (n = 7), and one classified as "other" (a composite definition of socioeconomic status used in that paper). The relationships presented data on the following measures: abdominal obesity (n = 48), aspects of diet (n = 31), blood pressure control (n = 6), diabetes incidence (n = 1), diabetes mortality (n = 3), diabetes prevalence (n = 71), diabetic retinopathy (n = 1), obesity (n = 80), pre-diabetes/hyperglycemia (n = 15), physical inactivity (n = 78), and smoking and tobacco use (n = 41). It was possible to have more than one paper published for a study. Measures were included in the narrative review when at least four relationships from multiple studies were available. A full matrix of relationships of outcomes by social determinants is available in Table 1. Overall relationship quality from risk of bias was as follows: high risk (n = 98), medium risk (n = 127), low risk (n = 68), and unclear (n = 81).

Measures of obesity

No significant difference in abdominal obesity (defined as elevated waist circumference) by ethnicity was found in adolescents in Jamaica (black versus non-black [reference]; 16) or Guadeloupe (17). In Suriname (18, 19), rates of abdominal obesity were highest among Amerindian indigenous populations (71.6%, 95%CI = 62.5 – 79.8; Creole 46.5%, 95%CI = 40.9 – 52.0; Hindustani 65.5%, 95%CI = 62.3 – 68.6; Javanese 52.3%, 95%CI = 47.4 – 57.1; Maroon 52.2%; 95%CI = 47.4 – 57.1; Mixed 60.1%; 95%CI = 54.9 – 65.0). In addition, obesity measured by BMI (both as a continuous variable and as a prevalence ≥ 30kg/m²) was described by ethnicity in 9 relationships across 7 studies: in Jamaica (16), Guadeloupe (17, 20), Suriname (18, 19), Trinidad and Tobago (21), and Barbados and Cuba (22). Studies found no significant differences in rates of obesity among black Jamaican adolescents (odds ratio [OR]: 1.03; 95%CI = 0.55 – 1.93), or among black adults in Barbados and Cuba combined (OR:1.33; 95%CI = 0.97 – 1.81) when compared to "white" (term used in the sources) subjects (16, 22). In Suriname (18, 19), mean BMI was highest among Amerindian indigenous populations (BMI: 28.6, standard deviation [SD]: 5.6), Creoles (BMI: 27.1 , SD 6.1), Hindustani

FIGURE 1. Flowchart of the selection process highlighting the number of studies excluded and included in a study of diabetes and its risk factors in the Caribbean
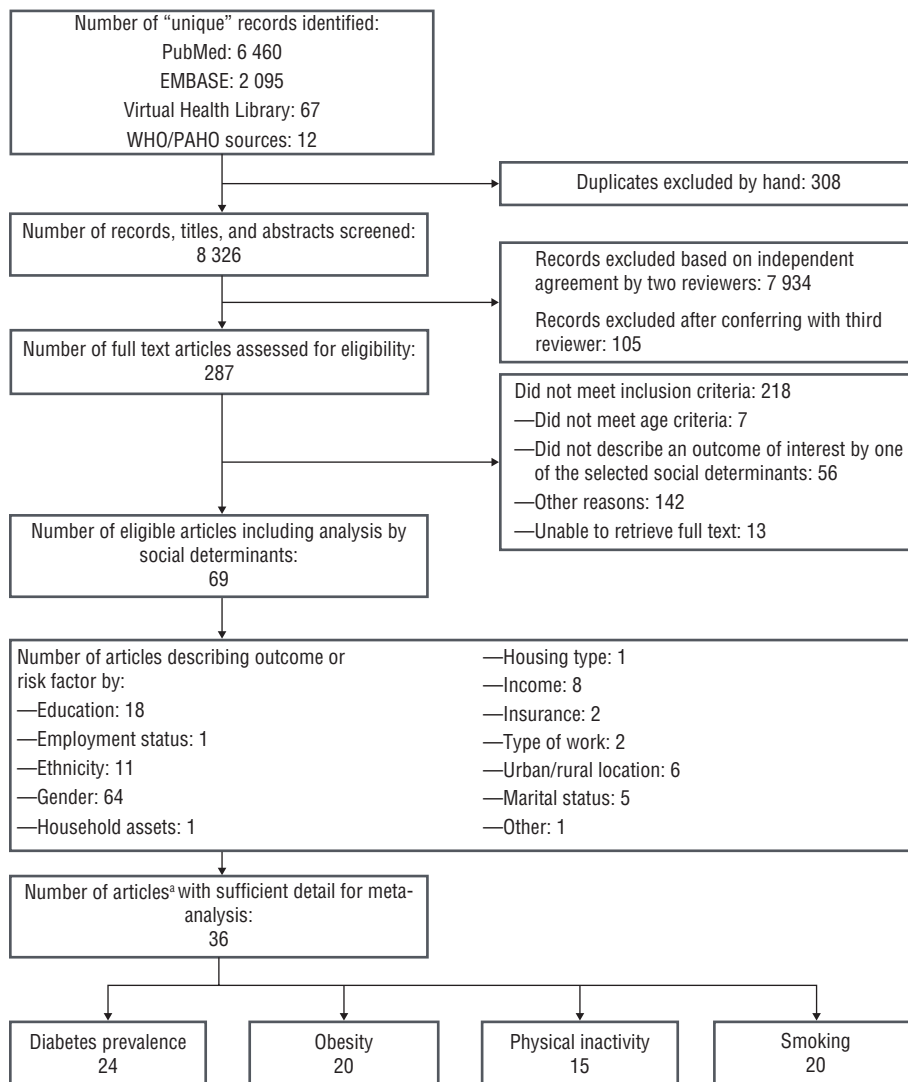
Source: Prepared by the authors from the study data.
ª The numbers below reflect the number of datapoints or relationships available for meta-analysis. Some articles presented data for more than one country, and therefore, yielded multiple points.

TABLE 1. Number of relationships found, by social determinant and outcome, in a study of the social determinants of diabetes and its risk factors in the Caribbean

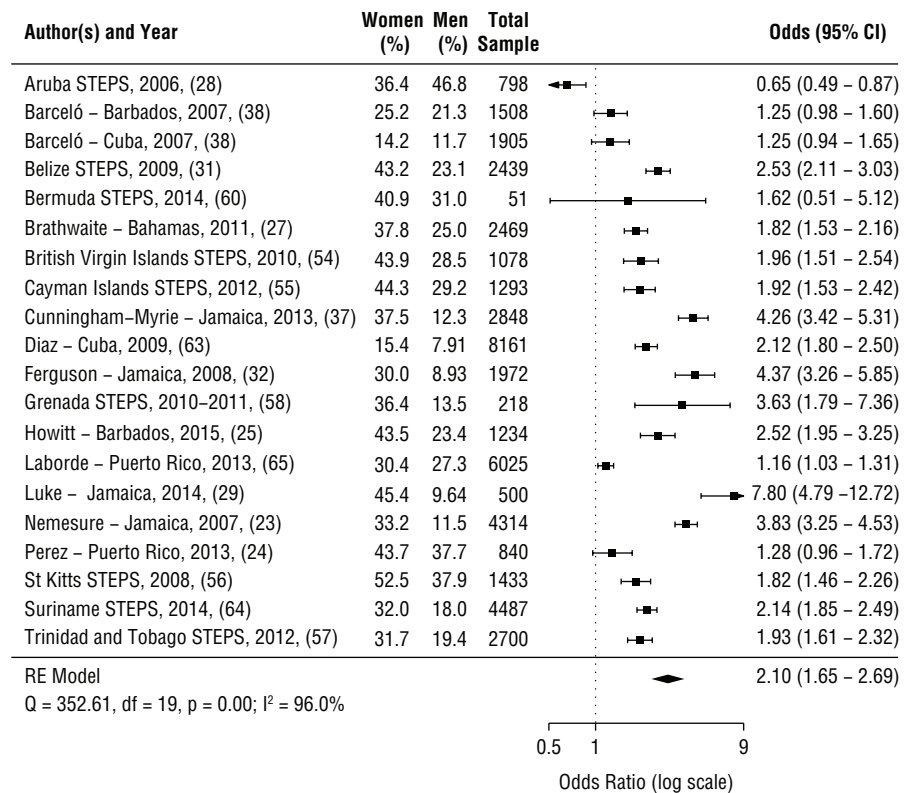| Risk factors and outcomes	Education	Employment	Ethnicity	Gender	Household assets	Housing type	Income	Health insurance	Urban/Rural location	Marital status	Total
Abdominal obesity	2	1	4	39	0	1	0	0	0	1	48
Aspect of diet	6	2	1	18	0	0	1	1	0	2	31
Diabetes incidence	0	0	0	1	1	0	3	0	0	0	5
Diabetes prevalence	10	3	5	40	0	1	0	1	5	2	67
Diabetic retinopathy	0	0	0	1	0	0	1	0	0	0	2
Hyperglycemia	1	0	1	9	0	0	0	2	1	0	14
Hypertension	0	0	1	5	0	0	0	0	0	0	6
Diabetes mortality	0	0	0	3	0	0	3	0	0	0	6
Obesity	6	2	4	62	0	0	2	0	1	0	77
Physical activity	4	2	5	63	0	0	0	0	2	0	76
Smoking/tobacco use	4	4	5	26	0	1	0	0	0	2	42
Total	33	14	26	267	1	3	10	4	9	7	374

Source: Prepared by the authors from study data.

(BMI: 27, SD 5.6), Javanese (BMI: 27.4; SD 5.5), Maroon (BMI: 27.3, SD 6.2), and Mixed (BMI: 27.4, SD 6.1), consistent with findings from the same study on elevated waist circumference. The study of Trinidad and Tobago did not provide details on confidence intervals or *P* values so it was not clear whether or not there were significant differences between ethnicities regarding obesity (21). In Guadeloupe, no differences by ethnicity were found for mean BMI.

Six relationships across five studies described obesity by level of education. No significant differences in obesity by education were found among adults in three studies in Barbados and Cuba (22) that used data from the Barbados Eye study (23); neither were differences found in the study of Puerto Rico (24). A nationally representative study from Barbados (25) showed differences in obesity by education level with the most obese being those with a secondary education (37.8%, 95%CI = 32.4 – 43.6), over those with the least education (28.6%, 95%CI = 23.1 – 34.8) and those with a university degree or higher (37.1%, 95%CI = 25.7 – 38.5); however, these differences were not significant. The studies from Barbados used different sampling methods and were conducted almost 20 years apart. Finally, a study among youth in Puerto Rico evaluated relationships between parental education and obesity, but found no significant relationship (26), and another in the Bahamas did not provide a clear description of educational levels (27).

Of 34 relationships assessing obesity (BMI) and 14 assessing elevated WC by gender, only one study found more obesity in men than women (28). Meta-analysis of obesity prevalence by gender is presented in Figure 2a. Obesity prevalence was reported by 27 data sources; of those, 7 were excluded due to duplicate data, leaving a total of 20 relationships.

FIGURE 2a. Forest plot of odds of obesity by gender, women versus men (reference), in a study of the social determinants of diabetes and its risk factors in the Caribbean

(A) Forest plot of odds of obesity by gender, women v men(ref)

Author(s) and Year	Women (%)	Men (%)	Total Sample	Odds (95% CI)
Aruba STEPS, 2006, (28)	36.4	46.8	798	0.65 (0.49 – 0.87)
Barceló – Barbados, 2007, (38)	25.2	21.3	1508	1.25 (0.98 – 1.60)
Barceló – Cuba, 2007, (38)	14.2	11.7	1905	1.25 (0.94 – 1.65)
Belize STEPS, 2009, (31)	43.2	23.1	2439	2.53 (2.11 – 3.03)
Bermuda STEPS, 2014, (60)	40.9	31.0	51	1.62 (0.51 – 5.12)
Brathwaite – Bahamas, 2011, (27)	37.8	25.0	2469	1.82 (1.53 – 2.16)
British Virgin Islands STEPS, 2010, (54)	43.9	28.5	1078	1.96 (1.51 – 2.54)
Cayman Islands STEPS, 2012, (55)	44.3	29.2	1293	1.92 (1.53 – 2.42)
Cunningham–Myrie – Jamaica, 2013, (37)	37.5	12.3	2848	4.26 (3.42 – 5.31)
Diaz – Cuba, 2009, (63)	15.4	7.91	8161	2.12 (1.80 – 2.50)
Ferguson – Jamaica, 2008, (32)	30.0	8.93	1972	4.37 (3.26 – 5.85)
Grenada STEPS, 2010–2011, (58)	36.4	13.5	218	3.63 (1.79 – 7.36)
Howitt – Barbados, 2015, (25)	43.5	23.4	1234	2.52 (1.95 – 3.25)
Laborde – Puerto Rico, 2013, (65)	30.4	27.3	6025	1.16 (1.03 – 1.31)
Luke – Jamaica, 2014, (29)	45.4	9.64	500	7.80 (4.79 –12.72)
Nemesure – Jamaica, 2007, (23)	33.2	11.5	4314	3.83 (3.25 – 4.53)
Perez – Puerto Rico, 2013, (24)	43.7	37.7	840	1.28 (0.96 – 1.72)
St Kitts STEPS, 2008, (56)	52.5	37.9	1433	1.82 (1.46 – 2.26)
Suriname STEPS, 2014, (64)	32.0	18.0	4487	2.14 (1.85 – 2.49)
Trinidad and Tobago STEPS, 2012, (57)	31.7	19.4	2700	1.93 (1.61 – 2.32)
RE Model				2.10 (1.65 – 2.69)

Q = 352.61, df = 19, p = 0.00; I² = 96.0%

Odds Ratio (log scale)

Source: Prepared by the authors using already published, publicly available data including tables and data presented in published papers and available on the PAHO (www.paho.org) and WHO (www.who.int) websites.

Overall, women in the Caribbean have 2.1 (95%CI = 1.65 – 2.69) higher odds of obesity than men, and as high as 7.8 (95%CI = 4.79 – 12.72) in a Jamaican sample (29). The only study reporting a higher odds in men than women was the Aruba STEPS survey (28).

FIGURE 2b. Forest plot of odds of smoking by gender, women versus men (reference), in a study of the social determinants of diabetes and its risk factors in the Caribbean

(B) Forest plot of odds of smoking by gender, men v women(ref)

Author(s) and Year	Women (%)	Men (%)	Total Sample		Odds (95% CI)
Anderson – Jamaica, 2011, (53)	11.4	40.3	847		5.22 (3.69 – 7.41)
Aruba STEPS, 2006, (28)	11.2	22.4	1 565		2.28 (1.73 – 3.00)
Barceló – Barbados, 2007, (39)	1.59	14.1	2 125		10.19 (5.36 – 19.35)
Barceló – Cuba, 2007, (39)	21.5	46.4	1 861		3.17 (2.58 – 3.88)
Belize STEPS, 2009, (31)	1.67	19.1	2 439		13.95 (9.04 – 21.51)
Benet – Cuba, 2014, (30)	21.0	30.3	2 193		1.63 (1.35 – 1.99)
Bermuda STEPS, 2014, (60)	7.55	19.9	1 195		3.04 (2.13 – 4.34)
Block – Grenada, 2012, (41)	6.45	30.6	1 124		6.41 (4.44 – 9.26)
British Virgin Islands STEPS, 2010, (54)	3.55	8.81	1 102		2.63 (1.55 – 4.45)
Cayman Islands STEPS, 2012, (55)	9.03	20.7	1 293		2.63 (1.90 – 3.64)
Colón–Ramos – Puerto Rico, 2013, (35)	17.8	24.1	858		1.47 (1.04 – 2.07)
Ferguson – Jamaica, 2008, (32)	7.32	28.3	1 972		4.99 (3.82 – 6.53)
Ferguson – Jamaica, 2010, (68)	14.6	34.9	748		3.14 (2.20 – 4.48)
Grenada STEPS, 2010, (58)	6.45	30.6	1 124		6.41 (4.44 – 9.26)
Howitt – Barbados, 2015, (25)	3.66	15.5	1 234		4.83 (3.07 – 7.60)
Krishnadath – Suriname, 2016, (18)	4.3	24.4	5 626		7.18 (5.94 – 8.69)
Nordet – Cuba, 2013, (69)	24.7	36.1	1 287		1.72 (1.34 – 2.21)
St Kitts STEPS, 2008, (56)	1.11	16.2	1 427		17.17 (8.83 – 33.40)
Trinidad and Tobago STEPS, 2012, (57)	9.38	33.5	2 723		4.87 (3.95 – 6.00)
Tulloch–Reid – Jamaica, 2013, (67)	5.91	31.3	1 432		7.27 (5.22 – 10.13)
RE Model					4.27 (3.18 – 5.74)

Q = 316.29, df = 19, p = 0.00; I² = 94.7%

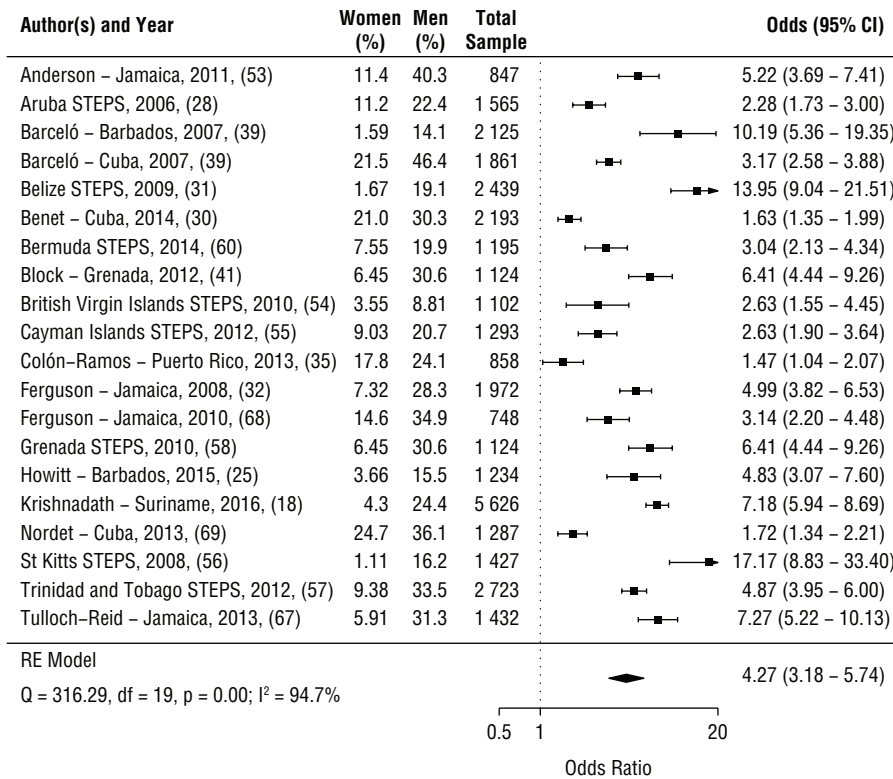0.5   1   20

Odds Ratio

Source: Prepared by the authors using already published, publicly available data including tables and data presented in published papers and available on the PAHO (www.paho.org) and WHO (www.who.int) websites.

Smoking and tobacco use

No study found a higher prevalence of smoking in women than men. In 19 of 26 relationships, the smoking rate for women was < 10% compared to > 15% – 34% for men. Two studies (25, 30) found decreasing prevalence of smoking or tobacco use with more years of education, although one survey in Belize did not find a clear pattern (31). In a meta-analysis of smoking and tobacco use by gender (Figure 2b), men had substantially higher odds of smoking (OR: 4.27; 95%CI = 3.18 – 5.74) than women.

Physical inactivity

Across all studies, women were less physically active than men. Nationally representative population-based surveys in Jamaica (male 16.0%; female 43.0; $P < 0.001$; 32), Suriname (recommended physical activity prevalence ratio: male [ref], female 0.78 [0.74 – 0.84] adjusted for age, ethnicity, area; 33), and Barbados (inactivity prevalence ratio: male versus female [ref] 0.47 [0.39 – 0.57] age adjusted; 25) all showed a significantly higher rate of physical inactivity in women compared to men. There was no consistent pattern between physical inactivity and years of education, although this was only assessed by four relationships across two studies. Physical inactivity and ethnicity were described in 5 relationships across 4 studies, but a variety of definitions for physical inactivity and classifications for ethnicity made it difficult to describe trends.

Meta-analysis of physical inactivity and gender (Figure 3a) yielded an odds ratio of 2.18 (95%CI = 1.75 – 2.72) higher in women than men, and ranged from 1.36 (95%CI = 1.11 – 1.66) in Aruba to 4.77 (95%CI = 3.72 – 6.11) in Barbados.

Aspects of diet

Eighteen relationships evaluated an aspect of diet, by gender, with fruit and vegetable intake as the most commonly measured indicator. Other measures included subjective diet quality, fast food consumption, and fat intake.

Prevalence of insufficient intake of fruit and vegetables (< 5 servings per day) were consistently > 80% for both genders across all studies. Intake tended to be lower in those with fewer years of education, but only 4 studies evaluated this relationship (25, 34 – 36). Meta-analysis (Figure 3b) showed higher odds of insufficient fruit and vegetable intake among men than women (OR: 1.37, 95%CI = 1.21 – 1.57), although absolute rates of insufficient intake were high across both genders.

Diabetes prevalence

Diabetes prevalence was significantly higher in people with less education in two studies in Jamaica (objectively measured prevalence: < high school education, 14.3%, 95%CI = 12.2 – 16.8; ≥ high school education, 4.9%, 95%CI = 3.9 – 6.1, $P < 0.001$; 37) and in Trinidad and Tobago (self-reported prevalence: primary education, 24.8%, $n = 2$ 267; secondary education 10%, $n = 427$; university education 7.3%, $n = 8$; $P = 0.000$; 38). No significant differences by education were found in Barbados (25, 39) or Belize (31), although trends were in the same direction. Only one study from Puerto Rico showed a trend of increased diabetes prevalence with more years of education (objectively measured prevalence: no formal education 6.6%; grades 1 – 8, 11.4%; ≥ high school education, 11.9%; $P = 0.013$; 40).

No significant differences were found regarding urban versus rural location and diabetes prevalence in 3 of 5 relationships in Belize (31) and Jamaica (32, 37). Only one study in Puerto Rico showed a significantly higher prevalence of diabetes in urban areas, but it was not age-adjusted (40).
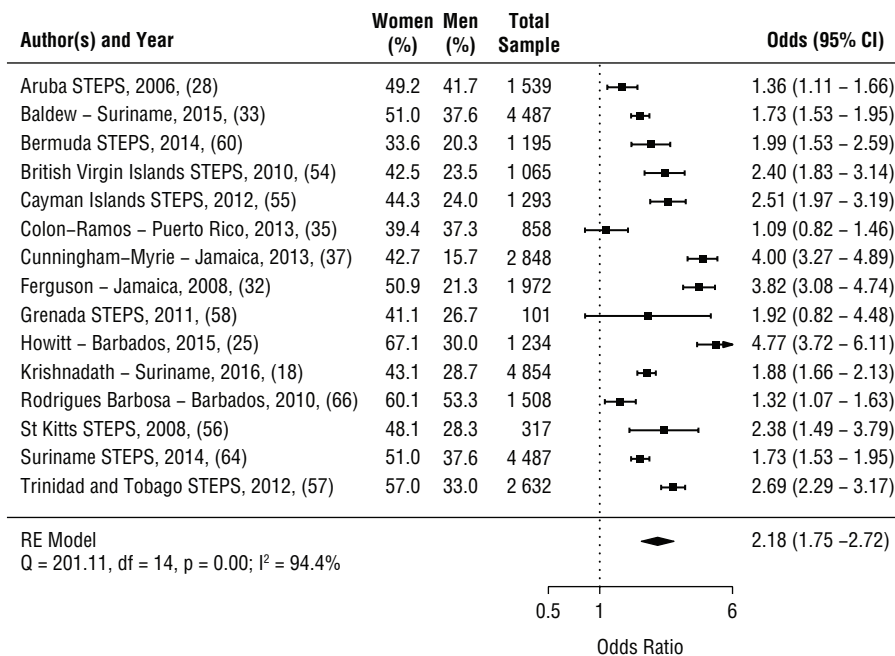
In meta-analysis, diabetes prevalence was higher for women than men in both objective (OR: 1.35, 95%CI = 1.03 – 1.76) and subjective (OR:1.62, 95%CI = 1.33 – 1.97) measurements (Figure 4).

Diabetes control and complications

Women with diabetes reported a higher prevalence of diagnosed high blood pressure than men in Barbados (women, 53.6%; men, 37.9%; $P < 0.001$), Cuba (women, 49.8%; men, 35.8%;

FIGURE 3a. Forest plot of odds of physical activity by gender, women versus men (reference), in a study of the social determinants of diabetes and its risk factors in the Caribbean
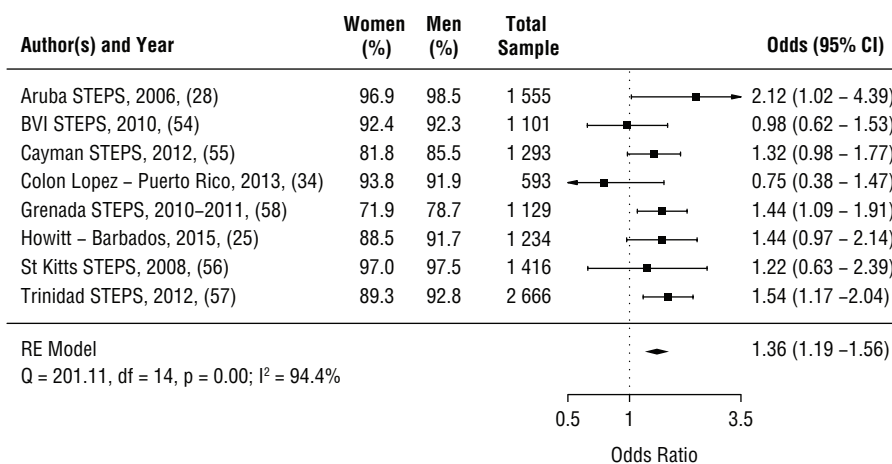
(A) Forest plot of odds of physical inactivity by gender, women v men(ref)

Author(s) and Year	Women (%)	Men (%)	Total Sample		Odds (95% CI)
Aruba STEPS, 2006, (28)	49.2	41.7	1 539		1.36 (1.11 – 1.66)
Baldew – Suriname, 2015, (33)	51.0	37.6	4 487		1.73 (1.53 – 1.95)
Bermuda STEPS, 2014, (60)	33.6	20.3	1 195		1.99 (1.53 – 2.59)
British Virgin Islands STEPS, 2010, (54)	42.5	23.5	1 065		2.40 (1.83 – 3.14)
Cayman Islands STEPS, 2012, (55)	44.3	24.0	1 293		2.51 (1.97 – 3.19)
Colon–Ramos – Puerto Rico, 2013, (35)	39.4	37.3	858		1.09 (0.82 – 1.46)
Cunningham–Myrie – Jamaica, 2013, (37)	42.7	15.7	2 848		4.00 (3.27 – 4.89)
Ferguson – Jamaica, 2008, (32)	50.9	21.3	1 972		3.82 (3.08 – 4.74)
Grenada STEPS, 2011, (58)	41.1	26.7	101		1.92 (0.82 – 4.48)
Howitt – Barbados, 2015, (25)	67.1	30.0	1 234		4.77 (3.72 – 6.11)
Krishnadath – Suriname, 2016, (18)	43.1	28.7	4 854		1.88 (1.66 – 2.13)
Rodrigues Barbosa – Barbados, 2010, (66)	60.1	53.3	1 508		1.32 (1.07 – 1.63)
St Kitts STEPS, 2008, (56)	48.1	28.3	317		2.38 (1.49 – 3.79)
Suriname STEPS, 2014, (64)	51.0	37.6	4 487		1.73 (1.53 – 1.95)
Trinidad and Tobago STEPS, 2012, (57)	57.0	33.0	2 632		2.69 (2.29 – 3.17)
RE Model Q = 201.11, df = 14, p = 0.00; I² = 94.4%					2.18 (1.75 –2.72)

0.5   1   6
Odds Ratio

Source: Prepared by the authors using already published, publicly available data including tables and data presented in published papers and available on the PAHO (www.paho.org) and WHO (www.who.int) websites.

FIGURE 3b. Forest plot of odds of insufficient fruit and vegetable intake by gender, women versus men (reference), in a study of the social determinants of diabetes and its risk factors in the Caribbean

(B) Forest plot of odds of insufficient fruit and vegetable intake by gender, women(ref) v men

Author(s) and Year	Women (%)	Men (%)	Total Sample		Odds (95% CI)
Aruba STEPS, 2006, (28)	96.9	98.5	1 555		2.12 (1.02 – 4.39)
BVI STEPS, 2010, (54)	92.4	92.3	1 101		0.98 (0.62 – 1.53)
Cayman STEPS, 2012, (55)	81.8	85.5	1 293		1.32 (0.98 – 1.77)
Colon Lopez – Puerto Rico, 2013, (34)	93.8	91.9	593		0.75 (0.38 – 1.47)
Grenada STEPS, 2010–2011, (58)	71.9	78.7	1 129		1.44 (1.09 – 1.91)
Howitt – Barbados, 2015, (25)	88.5	91.7	1 234		1.44 (0.97 – 2.14)
St Kitts STEPS, 2008, (56)	97.0	97.5	1 416		1.22 (0.63 – 2.39)
Trinidad STEPS, 2012, (57)	89.3	92.8	2 666		1.54 (1.17 –2.04)
RE Model Q = 201.11, df = 14, p = 0.00; I² = 94.4%					1.36 (1.19 –1.56)

0.5   1   3.5
Odds Ratio

Source: Prepared by the authors using already published, publicly available data including tables and data presented in published papers and available on the PAHO (www.paho.org) and WHO (www.who.int) websites.

P = 0.00), and Grenada (women, 35%; men, 21%; *P* < 0.001) (22, 41).

For blood glucose control, no significant difference by gender was found in Jamaica (32) or in Trinidad (42). Only one study from Suriname (43) estimated diabetic retinopathy by gender and found a higher age-adjusted rate among men (20.4%) than women (18.8%), but this difference was not significant.

Mortality

There were no studies that described mortality in populations or groups of people with diabetes by social determinants, and only one that found mortality in the general population (44); however, it did not meet the inclusion criteria.
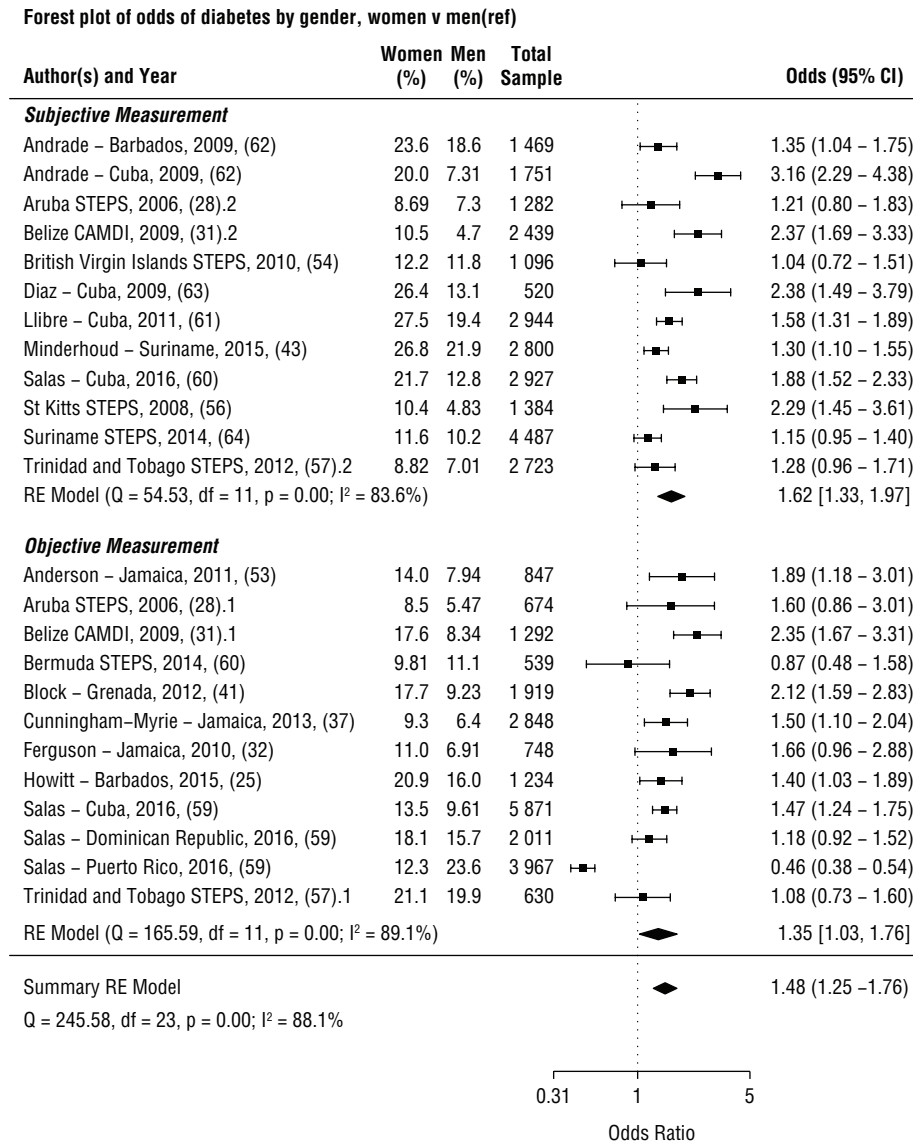
DISCUSSION

This update of the systematic review by Sobers-Grannum and colleagues (4) on diabetes distribution, risk factors, and outcomes in the Caribbean was designed to incorporate new evidence from peer-reviewed articles published in 1 January 2014 – 31 December 2016 and a broader scope that includes social determinants beyond gender. Moreover, this review features WHO STEP surveys that are largely unpublished in peer reviewed journals. The new data confirm findings from the original review indicating that women bear a higher burden of diabetes in the Caribbean. This higher burden can be partly attributed to a greater risk of obesity via lower levels of physical activity (and likely, dietary intake). This distribution is highly unusual in the global profile of diabetes (45) where most regions show men as having a higher prevalence than women. Adding data from WHO and PAHO surveys underscores this gender inequality and adds enough data to analyze physical inactivity and insufficient fruit and vegetable intake.

Both insufficient fruit and vegetable intake and tobacco use and smoking were more common in men than in women. Rates of insufficient fruit and vegetable intake were high across both genders, however, so measures should be taken at a population level to improve consumption. While smoking increases the risk of diabetes by as much as 50% (46), smoking rates in the Caribbean for men are typically around 20%, and for women, around 6%. These rates are low compared to other parts of the world. However, they are still a contributing factor to diabetes prevalence, particularly among men (47).

With respect to control and complications of diabetes, although the data were not conclusive, they were suggestive of poorer outcomes for women. Whether this reflects an overall increased burden for women or differences in health-seeking behavior or access to care remains to be evaluated.

FIGURE 4. Forest plot of odds of diabetes, by gender, women versus men (reference), in a study of the social determinants of diabetes and its risk factors in the Caribbean

Forest plot of odds of diabetes by gender, women v men(ref)

Author(s) and Year	Women (%)	Men (%)	Total Sample		Odds (95% CI)
Subjective Measurement					
Andrade – Barbados, 2009, (62)	23.6	18.6	1 469		1.35 (1.04 – 1.75)
Andrade – Cuba, 2009, (62)	20.0	7.31	1 751		3.16 (2.29 – 4.38)
Aruba STEPS, 2006, (28).2	8.69	7.3	1 282		1.21 (0.80 – 1.83)
Belize CAMDI, 2009, (31).2	10.5	4.7	2 439		2.37 (1.69 – 3.33)
British Virgin Islands STEPS, 2010, (54)	12.2	11.8	1 096		1.04 (0.72 – 1.51)
Diaz – Cuba, 2009, (63)	26.4	13.1	520		2.38 (1.49 – 3.79)
Llibre – Cuba, 2011, (61)	27.5	19.4	2 944		1.58 (1.31 – 1.89)
Minderhoud – Suriname, 2015, (43)	26.8	21.9	2 800		1.30 (1.10 – 1.55)
Salas – Cuba, 2016, (60)	21.7	12.8	2 927		1.88 (1.52 – 2.33)
St Kitts STEPS, 2008, (56)	10.4	4.83	1 384		2.29 (1.45 – 3.61)
Suriname STEPS, 2014, (64)	11.6	10.2	4 487		1.15 (0.95 – 1.40)
Trinidad and Tobago STEPS, 2012, (57).2	8.82	7.01	2 723		1.28 (0.96 – 1.71)
RE Model (Q = 54.53, df = 11, p = 0.00; I² = 83.6%)					1.62 [1.33, 1.97]
Objective Measurement					
Anderson – Jamaica, 2011, (53)	14.0	7.94	847		1.89 (1.18 – 3.01)
Aruba STEPS, 2006, (28).1	8.5	5.47	674		1.60 (0.86 – 3.01)
Belize CAMDI, 2009, (31).1	17.6	8.34	1 292		2.35 (1.67 – 3.31)
Bermuda STEPS, 2014, (60)	9.81	11.1	539		0.87 (0.48 – 1.58)
Block – Grenada, 2012, (41)	17.7	9.23	1 919		2.12 (1.59 – 2.83)
Cunningham–Myrie – Jamaica, 2013, (37)	9.3	6.4	2 848		1.50 (1.10 – 2.04)
Ferguson – Jamaica, 2010, (32)	11.0	6.91	748		1.66 (0.96 – 2.88)
Howitt – Barbados, 2015, (25)	20.9	16.0	1 234		1.40 (1.03 – 1.89)
Salas – Cuba, 2016, (59)	13.5	9.61	5 871		1.47 (1.24 – 1.75)
Salas – Dominican Republic, 2016, (59)	18.1	15.7	2 011		1.18 (0.92 – 1.52)
Salas – Puerto Rico, 2016, (59)	12.3	23.6	3 967		0.46 (0.38 – 0.54)
Trinidad and Tobago STEPS, 2012, (57).1	21.1	19.9	630		1.08 (0.73 – 1.60)
RE Model (Q = 165.59, df = 11, p = 0.00; I² = 89.1%)					1.35 [1.03, 1.76]
Summary RE Model					1.48 (1.25 –1.76)

Q = 245.58, df = 23, p = 0.00; I² = 88.1%

0.31   1   5

Odds Ratio

Source: Prepared by the authors using already published, publicly available data including tables and data presented in published papers and available on the PAHO (www.paho.org) and WHO (www.who.int) websites.

In the interest of capturing a wide range of information, the meta-analyses included all sources, regardless of risk of bias. In sensitivity analyses, excluding studies considered high risk did not affect the strength or direction of effect sizes (these data are available upon request from the corresponding author). Most of the studies were population-based, with generally high response rates and a mix of objective and subjective measures.

A major finding that limited the analytic capacity of the data was the heterogeneity of definitions of social determinants among the studies. For example, some authors defined education by the mean years of education, while others categorized according to completion of a particular education level. This variation in definition and categorization limited between-study comparison—excluding potentially worthwhile data from the analysis on the basis of incompatibility. The WHO STEPwise approach is an example of a standardized methodology that collects several social determinants data in a systematic way (e.g., gender, age, marital status, education, and income) across many countries (7). However, typically STEPS surveys are too small to have sufficient statistical power

for meaningful sub-group analyses by social determinant, tending instead to provide precise estimates of prevalence for men, women, and age groups combined. The methodology does not provide sufficient statistical power for stratification by other indicators at the country level. Alternatively, existing sources could be pooled to add statistical power and enable regional estimates of other social determinants by outcome. If leading organizations, such as WHO and PAHO, were to promote the use of standardized, operational definitions of social determinant indicators, they could facilitate more robust and comparable research of health inequalities.

Limitations. A major limitation of this review was the poor data quality and study reports. Of the total articles, 60% were classified as having a high or moderate risk of bias, with a lack of adjustment for age and other confounders being the largest contributing factor(s). Also, a large proportion of articles lacked detailed descriptions of methodology and outcomes, participant selection, measurement, and confounding. Many had missing data. These issues contributed to > 20% of papers being classified as having an "unclear" risk of bias. Other systematic reviews of non-randomized evidence in the Caribbean have also reported large proportions with a high risk of bias (14, 48). This speaks to the quality of reporting in the region and the necessity for establishing and adopting reporting standards to improve output.

Despite the wide scope of this systematic review, heterogeneous definitions of social determinants (especially education levels, income groups, and measures of socioeconomic status) and outcome measures made it impossible to conduct meta-analyses beyond gender. Opportunities are available for more detailed reporting by social determinants in the STEPS surveys where standardized data on education and income have been collected. However, most of these surveys have not published analyses by social determinants beyond gender and the technical capacity for further analysis is often limited. Data sharing has not been a regional priority, further limiting data reuse.

Conclusions

This systematic review confirms that women are disproportionately affected

by type 2 diabetes risk factors in the Caribbean. While efforts have been made to move forward with the Port of Spain Declaration to stop the epidemic of noncommunicable disease (5), targeted prevention strategies are still needed. Describing the differences in proportions of risk factors is useful, but understanding the mechanisms explaining this disparity using qualitative analysis of the perceptions of women and men in the Caribbean is vital (49) to developing targeted policy strategies. Governments have recognized the importance of understanding the social determinants of health starting with the WHO Commission on Social Determinants in 2005. In 2017, WHO chose the burden of diabetes on women and their right to health care as the theme for World Diabetes Day (50).

The evidence presented here confirms the greater burden borne by women with regards to obesity and physical inactivity, two major risk factors for diabetes and diabetes prevalence. It should help guide policymakers in focusing interventions on physical inactivity, obesity, and diabetes, as well as smoking-reduction campaigns. However, if health policy leaders, such as WHO and PAHO, are committed to closing the gaps and disparities associated with the social determinants of disease, a unified, standardized approach to measurement must be put forth and encouraged for country-level surveillance.

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RESUMEN

Revisión sistemática y metanálisis actualizados sobre los determinantes sociales de la diabetes y los factores de riesgo conexos en el Caribe

Objetivos. Analizar los datos más recientes sobre la diabetes y sus factores de riesgo desglosados por género y otros determinantes sociales de la salud para comprender por qué su prevalencia en el Caribe es mayor en las mujeres que en los hombres, fundamentar la definición de la agenda de políticas para la prevención y el control de la diabetes en el Caribe, y determinar las brechas en la evidencia que requieren mayor investigación.

Métodos. Se actualizó una revisión sistemática anterior de la bibliografía que describe los estudios realizados en el Caribe acerca de la distribución de la diabetes, sus resultados y sus factores de riesgo por uno o varios determinantes sociales, con el objetivo de incluir otras fuentes publicadas en el periodo comprendido entre el 1 de enero del 2007 y el 31 de diciembre del 2016, además de encuestas realizadas por la Organización Mundial de la Salud (OMS). En los casos en los que se contaba con datos suficientes, se emprendieron metanálisis.

Resultados. Se encontró un total de 8.326 artículos, entre los que se seleccionaron 282 para llevar a cabo un examen del texto íntegro y 114 para realizar un resumen. En conjunto, 36 artículos, entre los que se incluyen las encuestas relacionadas con la OMS, disponían de la información suficiente para su metanálisis. En comparación con los hombres, un mayor número de mujeres eran obesas (razón de posibilidades [OR]: 2,1; IC de 95% = 1,65 – 2,69), físicamente inactivas (OR: 2,18; IC de 95% = 1,75 – 2,72) y tenían diabetes (OR: 1,48; IC de 95% = 1,25 – 1,76). Un mayor número de hombres eran fumadores (OR: 4,27; IC de 95% = 3,18 – 5,74) y presentaban un consumo insuficiente de frutas y verduras (OR: = 1,37; IC de 95% = 1,21 – 1,57).

Conclusiones. Se agregaron 36 artículos a la revisión sistemática realizada con anterioridad y, de ellos, se añadieron 13 al metanálisis. La diabetes y sus factores de riesgo (fundamentalmente, la obesidad y la inactividad física) siguen afectando desproporcionadamente a las mujeres en el Caribe. En esta zona geográfica, las intervenciones contra el tabaquismo deben dirigirse a los hombres.

Palabras clave Diabetes mellitus; enfermedades no transmisibles; género y salud; obesidad; factores de riesgo; Región del Caribe.

RESUMO

Revisão sistemática e meta-análise atualizadas dos determinantes sociais da diabetes e fatores de risco relacionados no Caribe

Objetivos. Examinar os dados mais recentes sobre diabetes e fatores de risco relacionados por gênero e outros determinantes sociais da saúde para entender por que a prevalência da doença é maior no sexo feminino que no masculino no Caribe; obter subsídios para estabelecer a agenda de políticas para prevenção e controle da diabetes no Caribe; e identificar as lacunas nas evidências que precisam de uma investigação mais aprofundada.

Métodos. Uma revisão sistemática anterior da literatura de estudos realizados no Caribe que apresentavam dados da distribuição da diabetes, desfechos e fatores de risco relacionados a esta doença, por um ou mais determinantes sociais, foi atualizada com a inclusão de novas fontes de informação para o período de 1º de janeiro de 2007 a 31 de dezembro de 2016. Foram incluídas também pesquisas feitas pela Organização Mundial da Saúde (OMS). Meta-análises foram conduzidas quando havia dados suficientes.

Resultados. Ao todo, 8.326 manuscritos foram identificados. Destes, 282 foram selecionados para leitura completa de texto e 114 foram separados para a coleta de dados. Trinta e seis artigos, incluindo as pesquisas da OMS, continham dados suficientes para uma meta-análise. Verificou-se uma proporção maior de mulheres em comparação aos homens com obesidade (OR 2,1; IC95% 1,65–2,69), inatividade física (OR 2,18; IC95% 1,75–2,72) e diabetes (OR 1,48; IC95% 1,25–1,76). Observou-se também que uma proporção maior de homens era fumante (OR 4,27; IC95% 3,18–5,74) e tinha consumo inadequado de frutas e verduras (OR 1,37; IC95% 1,21–1,57).

Conclusões. Foram acrescentados 36 artigos à revisão sistemática anteriormente realizada. Destes, 13 foram incluídos na meta-análise. A diabetes e fatores de risco relacionados (sobretudo obesidade e inatividade física) continuam afetando de forma desproporcional as mulheres no Caribe. Intervenções para combater o tabagismo devem ser dirigidas ao sexo masculino nesta região geográfica.

Palavras-chave Diabetes mellitus; doenças não transmissíveis; gênero e saúde; obesidade; fatores de risco; Região do Caribe.