

# Prevalence of hypertension and obesity in patients with type 2 diabetes mellitus in observational studies: a systematic literature review

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**Background:** Hypertension and obesity are known to contribute, directly or indirectly, to the development of long-term complications of type 2 diabetes mellitus (T2DM). Knowing the prevalence of these comorbidities is important for determining the size of the population that may benefit from strategies that reduce blood pressure and weight while controlling blood glucose.

**Methods:** In this systematic literature review, electronic searches of PubMed, Embase, and the Cochrane Library were conducted to identify observational studies of hypertension and/or obesity prevalence in patients with T2DM throughout the world. The searches were limited to studies reported in English from January 1, 2001 to February 16, 2012.

**Results:** From a total of 2,688 studies, 92 observational studies provided prevalence rates for hypertension and/or obesity specifically in adults with T2DM. Fifteen studies of specific subtypes of hypertension or subpopulations with T2DM were subsequently excluded, leaving 78 studies (in 77 articles) for inclusion in this article. Of these, 61 studies reported hypertension prevalence, 44 reported obesity prevalence, and 12 reported the prevalence of hypertension with obesity. Most studies had a low risk of bias regarding diagnosis of T2DM (70/78), hypertension (59/69), or obesity (45/47). The continental regions with the most observational studies of hypertension or obesity prevalence were Europe (n = 30) and Asia (n = 26). Hypertension rates typically were high in all regions; most studies presented rates above 50%, and many presented rates above 75%. Obesity rates exceeded 30% in 38 of 44 studies and 50% in 14 of 44 studies, especially those assessing central obesity (based on waist circumference). Among obese adults, hypertension rates were at or above 70% in Asia and above 80% in Europe; rates were lower in North and South America but still above 30%.

**Conclusion:** Around the world, hypertension and obesity, separately or together, are common comorbidities in adults with T2DM.

**Keywords:** epidemiology, waist circumference, blood pressure, body mass index, T2DM

## Introduction

Hypertension<sup>1-6</sup> and obesity<sup>7-13</sup> increase the risk of long-term vascular complications of type 2 diabetes mellitus (T2DM), including stroke, chronic kidney disease, heart disease, peripheral vascular disease, and death. The relative risk of cardiovascular disease for persons with diabetes is double or more than that of persons without diabetes,<sup>14</sup> although the absolute risk of cardiovascular disease varies around the world. Hypertension and obesity among patients with T2DM in developing countries are perhaps even more harmful than in high-income countries, where access to health care and adequate prevention programs help manage cardiovascular risk factors<sup>15</sup> and can delay complications.<sup>16</sup> Blood pressure reduction has been associated with a decreased

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risk of T2DM-related complications, including death, stroke, and the need for retinal photocoagulation.<sup>17</sup> Weight loss helps correct insulin resistance and dyslipidemia found in patients with T2DM.<sup>18</sup> Deaths from cardiovascular disease and diabetes are highest in low- and middle-income countries and lowest in high-income countries.<sup>19</sup> Within all countries, the poorest people are affected the most.<sup>19</sup> Recent recommendations from the American Diabetes Association and the European Association for the Study of Diabetes note that aggressive management of cardiovascular risk factors, which include high blood pressure and obesity, may be even more beneficial in patients with T2DM because of their increased risk of cardiovascular morbidity and mortality.<sup>20</sup>

Knowing the proportion of the T2DM population at additional risk of complications from hypertension and obesity is an important public health measure to determine public and private resource requirements to reduce these risk factors or to care for patients after cardiovascular events. Many epidemiologic reports describe separate prevalence rates for hypertension, obesity, and diabetes among the general population<sup>19,21–25</sup> or present prevalence rates of hypertension or obesity in patients with diabetes but often without separating data for type 1 versus type 2 diabetes.<sup>26–28</sup> This systematic literature review was conducted to determine the rates of hypertension and/or obesity among patients with T2DM as reported in observational studies.

## Methods

### Patient population

Studies included in this systematic literature review were observational in design and reported hypertension and/or obesity prevalence for adults (aged  $\geq 18$  years) with T2DM.

### Data sources and search methods

The computerized literature search included published studies indexed in PubMed, Embase, the National Health Service Economic Evaluation Database (NHS EED) (searched July 25, 2011), and the Cochrane Library (without NHS EED) (searched August 2, 2011) dating back to January 1, 2001. An updated and expanded epidemiology search was conducted on February 16, 2012 for publications dating back to January 1, 2001. The 10-year period was chosen to capture the most recent prevalence literature. Given the dynamic nature of obesity and hypertension over the last several decades,<sup>19</sup> recent literature was preferred to allow an understanding of the current prevalence rates of hypertension and/or obesity within T2DM populations. This research was not focused on trends. The search strategies used a combination of medical

subject heading (MeSH) terms and title words for the disease state of interest (“type 2 diabetes mellitus”), the comorbidities of interest (“hypertension,” “blood pressure,” or “obesity”) and epidemiology terms (“morbidity,” “incidence,” “prevalence,” and the “epidemiology” subheading for the “obesity” and “hypertension” MeSH terms).

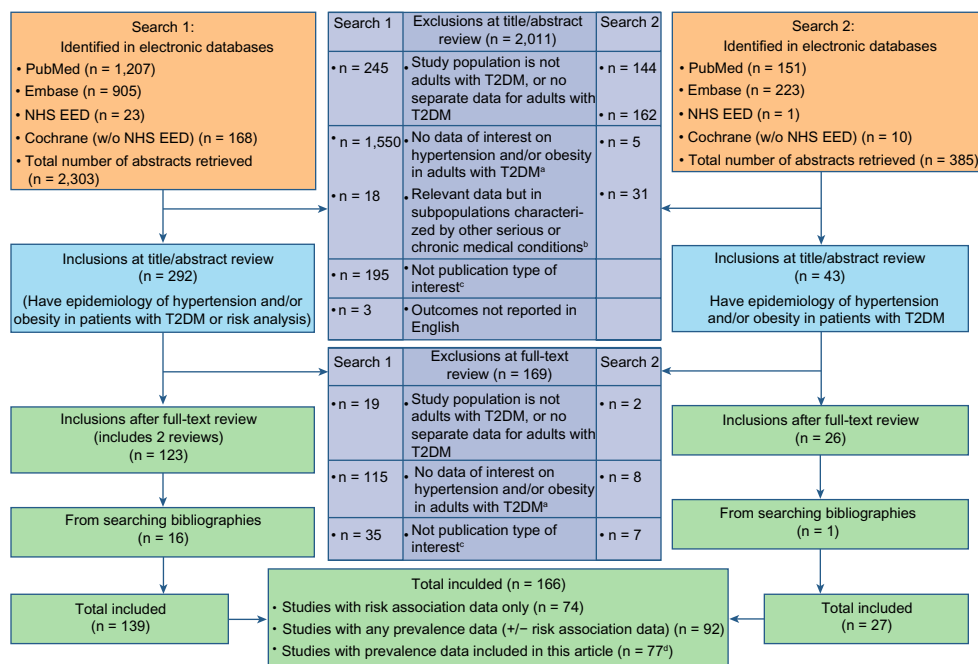
The full search strategies are available in Tables S1 and S2 online at [http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables\\_20Aug2013.pdf](http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables_20Aug2013.pdf).

### Study selection and data extraction

Two independent reviewers (ADC and one other researcher at RTI Health Solutions) examined the titles and abstracts of articles identified in the database searches for potential relevance. Included studies presented prevalence rates for hypertension and/or obesity in patients with T2DM evaluated in observational, noninterventional studies. Studies of hospitalized patients were also included. Studies were excluded if prevalence rates were not available for patients with T2DM; if the T2DM population was defined by having another chronic illness, such as cancer or atrial fibrillation; or if the study was not reported in English (Figure 1). The inclusion criteria did not include preestablished definitions of hypertension and obesity but instead relied on the identified articles to define these. For potentially relevant sources, the full articles were obtained and reviewed to determine whether prevalence data were specific to patients with T2DM. Study details were extracted into tables by one reviewer, while the content of the tables was verified by a second reviewer not involved in the data extraction. The reviewers discussed each article to reach consensus regarding the study details.

For each study, the following data were extracted: author(s); publication year; country of origin; study design; study population size and description; data-collection period; and prevalence rates for hypertension, obesity, and hypertension with obesity. The principal summary measures were the percentage of patients with T2DM and hypertension, obesity, or hypertension with obesity. (Data were extracted by ADC and one other researcher at RTI Health Solutions.)

Risk of misclassification bias was assessed for each disease state of interest. Involvement of a health care professional in determining the presence of a disease state was considered to confer a low risk of misclassification, whereas patient self-reporting was considered to confer a high risk. Risk of bias was unclear when the study did not meet the definition for low risk of bias but also did not rely exclusively on self-reporting. (The full criteria for risk of bias and the individual study assessments are available in Tables S3 and S4



**Figure 1** Flow diagram of review and inclusion/exclusion (Preferred Reporting Items for Systematic reviews and Meta-Analyses [PRISMA]).

**Notes:** <sup>a</sup>Data of interest = incidence or prevalence of hypertension and/or obesity among adults with T2DM (searches one and two) or risk association of hypertension/obesity with long-term micro- or macrovascular complications of T2DM (search one only); <sup>b</sup>does not exclude patients hospitalized with T2DM complications; <sup>c</sup>publication types excluded were commentaries, case studies, interim reports when end-of-study data were available, and reviews for which primary data were already included; <sup>d</sup>one article (Thomas and Atkins<sup>29</sup>) reported on two studies, for a total of 78 studies in 77 articles.

**Abbreviations:** NHS EED, National Health Service Economic Evaluation Database; T2DM, type 2 diabetes mellitus.

online at [http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables\\_20Aug2013.pdf](http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables_20Aug2013.pdf).

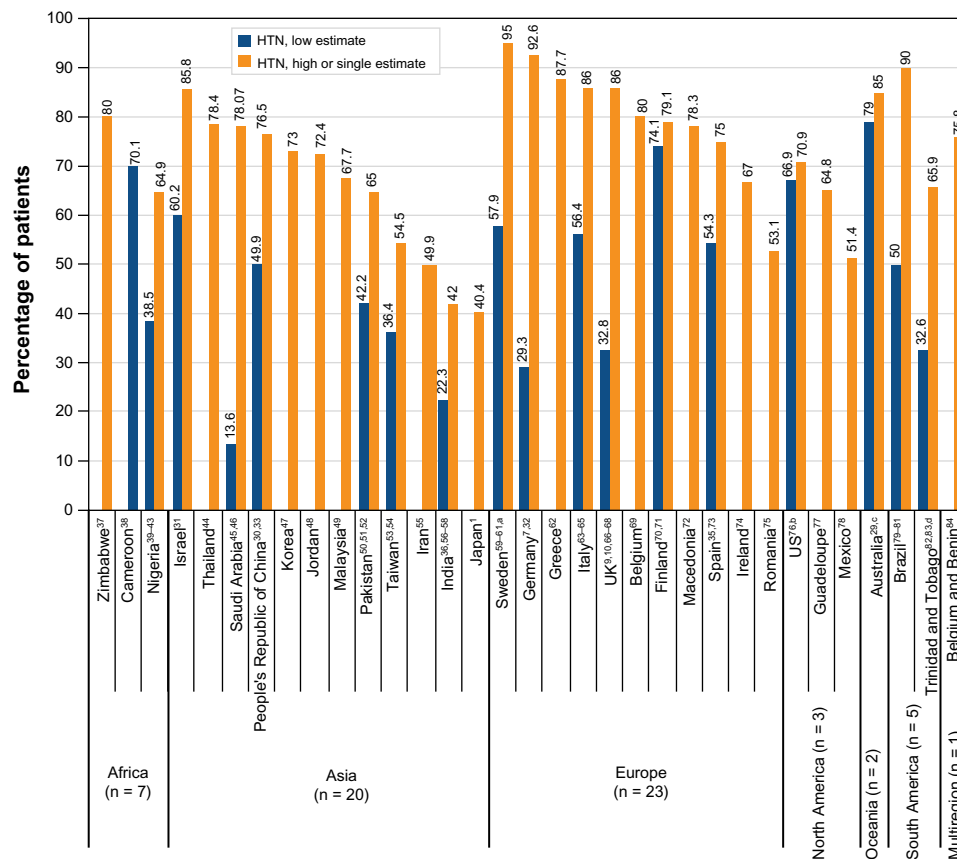
## Results

From both searches, 2,688 titles and abstracts were identified from the electronic databases. Of these, 335 full-text articles were obtained and reviewed, of which 92 studies met the inclusion criteria. Fifteen studies of patient subpopulations (eg, other medical conditions) or specific subclassifications of hypertension (eg, masked hypertension) were omitted, leaving 78 studies in 77 articles for inclusion in this review. The included studies reported the prevalence of hypertension and/or obesity for patients with T2DM. Of these, 61 studies reported hypertension prevalence, 44 studies reported obesity prevalence, and 12 studies reported the prevalence of hypertension with obesity. Europe (n = 30) and Asia (n = 25) were the continental regions with the greatest number of observational studies of hypertension or obesity prevalence. Table S5 (online at [http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables\\_20Aug2013.pdf](http://www.rtihs.org/supplemental/ColosiaManuscriptSupplTables_20Aug2013.pdf)) gives a more detailed description of each study. The regions with the largest studies of T2DM populations were Europe (maximum N = 180,369; median 1,610), North America (maximum N = 138,336; median, 1,512), and Asia

(maximum N = 89,857; median, 669). Smaller studies were conducted in Oceania (combined N = 5,724 for two studies), Africa (maximum N = 601; median, 218), and South America (maximum N = 842; median, 270). Most of the study populations had a mean age between 50 and 70 years. All regions except South America also included analyses of populations with mean ages between 30 and 50 years. Europe also had studies with mean ages between 70 and 90 years.

## Prevalence of hypertension

Among the reviewed studies, hypertension was defined as blood pressures  $\geq 140/90$ ,  $130/85$ , and  $130/80$  mmHg or the use of antihypertensive medications. Hypertension prevalence usually increased within a study with decreasing blood pressure cut points<sup>30-36</sup> (eg, dropping the hypertension definition from  $\geq 140/90$  to  $\geq 130/80$  mmHg). However, among all of the included studies, there was no clear pattern when the hypertension prevalence rates among patients with T2DM were compared within a region by differing hypertension definitions (analysis not shown). Therefore, the data presented graphically in Figure 2 are not segregated by hypertension definition. Figure 2 shows the prevalence rates of hypertension by the regions alphabetically, with countries within a region ranked by the highest estimate.



**Figure 2** Hypertension (HTN) prevalence rates among patients with type 2 diabetes mellitus.

**Notes:** Superscript numbers correspond to reference numbers. For countries with more than one reference citation, the citations are provided in the following order: study presenting the low estimate; study presenting the high estimate; and, if applicable, study or studies presenting mid-range value(s). Mid-range values are not shown in the figure. <sup>a</sup>Mean ages in the study by Hassing et al<sup>59</sup> were 83.1–84.0 years; <sup>b</sup>Suh et al<sup>76</sup> provided both low and high estimates; <sup>c</sup>Thomas and Atkins<sup>29</sup> provided both low and high estimates (two studies in one report); <sup>d</sup>the low estimate in South America used an atypical definition of hypertension (the proportion of patients with systolic blood pressure > 144 mmHg).<sup>82</sup>

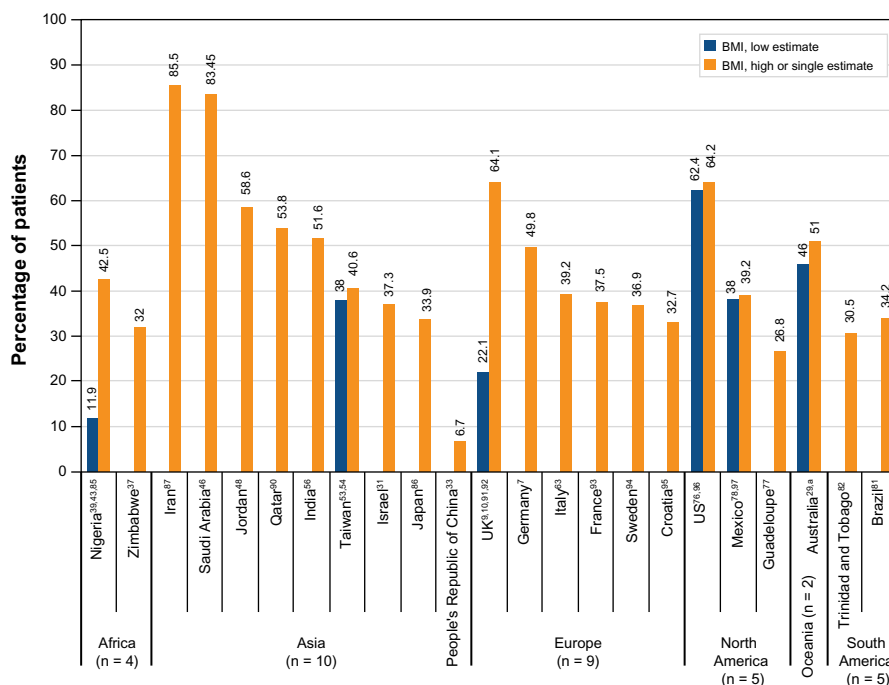
## Prevalence of obesity

Obesity prevalence was assessed primarily by body mass index (BMI) and waist circumference, although some studies also assessed obesity by waist-to-hip ratio.<sup>32,34,35,56,85</sup> In all regions, the cut point for defining obesity by BMI was 30 kg/m<sup>2</sup>, except in a few Asian studies, in which the cut point was 25 kg/m<sup>2</sup>,<sup>56,86</sup> or 25 kg/m<sup>2</sup> for men and 27 kg/m<sup>2</sup> for women.<sup>53</sup> For waist circumference, obesity was most commonly defined as measurements of at least 88 cm for women and at least 102 cm for men (in Africa,<sup>41</sup> Asia,<sup>33,52,56,87</sup> and Europe<sup>32,34,88</sup>). (These waist circumference cut points for increased cardiometabolic risk in women and men were derived from waist circumferences that correlated with a BMI  $\geq$  30 kg/m<sup>2</sup> in a US population. A small minority of the populations in the US, Europe, Australia, and New Zealand with BMI below the obese range had waist circumference values in the obese range).<sup>89</sup>

Figure 3 shows the prevalence rates of obesity by BMI, and Figure 4 shows obesity prevalence by waist circumference

with regions presented alphabetically, and countries within a region ranked by the highest estimate. Obesity rates were well above 30% in 38 of 44 of the studies. There were no data from observational studies on obesity prevalence by waist circumference for North America or Oceania. In Europe, when obesity was defined by at least one of two measures (elevated BMI or waist-to-hip ratio), obesity was present in 50.9%<sup>32</sup> to 98.6%<sup>35</sup> of adults with T2DM. In Asia, obesity was present in 56.1% of adults with T2DM when the criteria were elevated BMI (>30 kg/m<sup>2</sup>) or waist-to-hip ratio, which was a much higher rate than using BMI alone (6.7%).<sup>33</sup> Another study in Asia reported an obesity prevalence of 69.2% of adults with T2DM by high waist-to-hip ratio.<sup>56</sup>

Table 1 shows the prevalence of obesity by BMI class. The US studies show increases in class 2 and 3 obesity over time nationally in adults with T2DM<sup>96</sup> and in American Indian and Alaska Native adults with T2DM.<sup>100</sup> In the national population, there was a 58% rise in overall obesity from 1976 to 2004, with a 140% rise in class 3 obesity.<sup>96</sup>



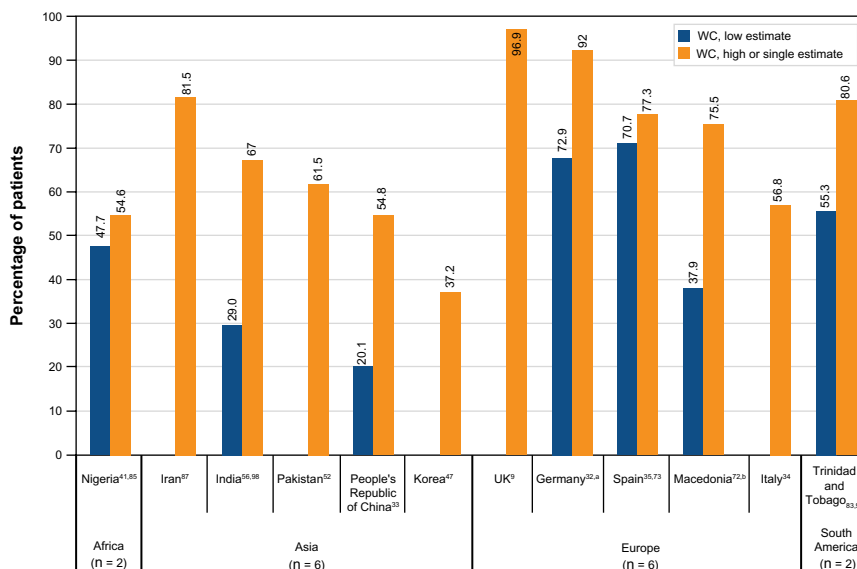
**Figure 3** Prevalence of obesity defined by body mass index (BMI) among patients with type 2 diabetes mellitus.

**Notes:** Superscript numbers correspond to reference numbers. For countries with more than one reference citation, the citations are provided in the following order: study presenting the low estimate; study presenting the high estimate; and, if applicable, study or studies presenting mid-range value(s). Mid-range values are not shown in the figure. <sup>3</sup>Thomas and Atkins<sup>29</sup> provided both low and high estimates (two studies in one report).

### Prevalence of hypertension with obesity

Five studies reported the rate of both hypertension and obesity among patients with T2DM.<sup>7,43,82,88,99</sup> In Africa (Nigeria<sup>43</sup>), the presence of both hypertension and obesity defined by BMI was found in 44.9% of patients with T2DM. In Europe, two studies

found similar rates of coexistence of these comorbidities when obesity was defined by BMI (50.7% in Germany<sup>7</sup>) or waist circumference (52% in Italy<sup>88</sup>). In South America, two studies of the same population found higher rates of coexistence with hypertension (systolic blood pressure >144 mmHg or dia-



**Figure 4** Prevalence of obesity defined by waist circumference (WC) among patients with type 2 diabetes mellitus.

**Notes:** Superscript numbers correspond to reference numbers. For countries with more than one reference citation, the citations are provided in the following order: study presenting the low estimate; study presenting the high estimate. <sup>3</sup>Koehler et al<sup>32</sup> provided both low and high estimates; <sup>a</sup>Bosevski et al<sup>72</sup> provided both low and high estimates.

**Table 1** Prevalence (%) of body mass index (BMI) classes of obesity

Region/Country	Prevalence by BMI Class
<b>Africa</b>	
Nigeria <sup>85</sup>	BMI Classes 1 and 2: <sup>a</sup> 14.3 BMI Class 3: <sup>b</sup> 4.3
<b>Europe</b>	
UK <sup>91</sup>	BMI Class 1: <sup>c</sup> 20.9 BMI Classes 2 and 3: <sup>d</sup> 9.6
UK <sup>9</sup>	BMI Class 1: <sup>e</sup> 29 BMI Class 2: <sup>f</sup> 21.3 BMI Class 3: <sup>b</sup> 13.8
<b>North America</b>	
US (Alaskan Natives and American Indians) <sup>100</sup>	BMI Class 1: <sup>e</sup> 30.9 (in 1995); 28.9 (in 2004) BMI Class 2: <sup>f</sup> 16.7 (in 1995); 20.4 (in 2004); $P < 0.001$ BMI Class 3: <sup>b</sup> 11.5 (in 1995); 20.3 (in 2004); $P < 0.001$
US (national population sample) <sup>96</sup>	BMI Class 3: <sup>b</sup> 8.6 (in NHANES II); 20.7 (in NHANES 2005–2006); $P < 0.0001$
<b>Asia</b>	
Taiwan <sup>54</sup>	BMI Class 1: <sup>g</sup> 33.5 BMI Class 2: <sup>h</sup> 7.1

**Notes:** <sup>a</sup>BMI 30–39.9 kg/m<sup>2</sup>; <sup>b</sup>BMI  $\geq$  40 kg/m<sup>2</sup>; <sup>c</sup>BMI 30–34 kg/m<sup>2</sup>; <sup>d</sup>BMI  $\geq$  35 kg/m<sup>2</sup>; <sup>e</sup>BMI 30–34.9 kg/m<sup>2</sup>; <sup>f</sup>BMI 35–39.9 kg/m<sup>2</sup>; <sup>g</sup>BMI 25–29.9 kg/m<sup>2</sup>; <sup>h</sup>BMI  $\geq$  30 kg/m<sup>2</sup>.  
**Abbreviations:** NHANES, National Health and Nutrition Examination Survey; UK, United Kingdom; US, United States.

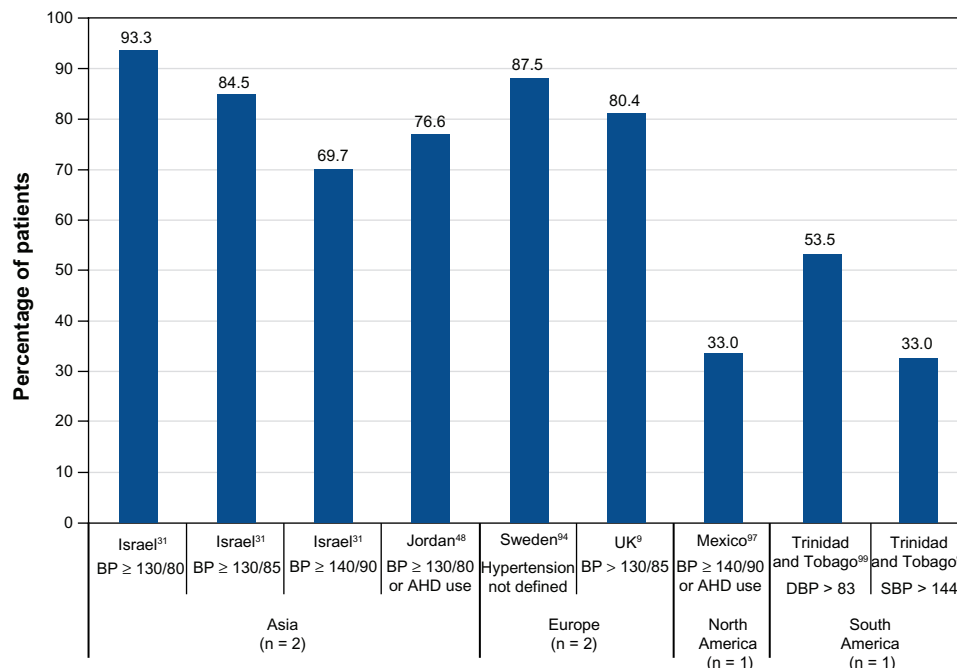
stolic blood pressure  $>83$  mmHg) when obesity was defined by waist circumference (18.2% and 29.5%, respectively) than by BMI (11.3% and 19.2%, respectively).<sup>82,99</sup>

Eight studies reported the presence of one comorbidity in patients with the other comorbidity.<sup>2,9,31,48,82,94,97,101</sup> Studies in Asia (Israel<sup>31</sup> and Jordan<sup>48</sup>) and Europe (Sweden<sup>94</sup> and the UK<sup>9</sup>) found a high prevalence ( $\geq 70\%$ ) of hypertension among obese patients (Figure 5). The rates were lower in single studies in North America (Mexico<sup>97</sup>) and South America (Trinidad

and Tobago<sup>82</sup>) but still above 30% (Figure 5). In the two studies that reported the rate of obesity among hypertensive patients, the rates were 43% in a European (Italian) study<sup>101</sup> and 10.7% in an Asian (Saudi Arabian) study.<sup>2</sup>

## Risk of bias

Most of the studies had a low risk of bias regarding diagnosis of T2DM, hypertension, or obesity. Only five of the 78 studies relied on self-reporting of T2DM ( $n = 4$ ),<sup>54,62,76,96</sup>

**Figure 5** Prevalence of hypertension among obese adults with type 2 diabetes mellitus.

**Abbreviations:** AHD, antihypertensive drug; BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure.

hypertension ( $n = 2$ ),<sup>54,93</sup> or obesity ( $n = 1$ ).<sup>54</sup> Two of the studies were European – one from France<sup>93</sup> and the other from Greece<sup>62</sup> – and one study was from Asia (Taiwan<sup>54</sup>). Four studies had unclear diagnostic criteria for T2DM in patients not attending diabetes clinics or hospitals – one from Asia,<sup>33</sup> two from Europe,<sup>70,71</sup> and one from North America.<sup>78</sup> Seven studies had unclear assessments of hypertension – one from Africa<sup>40</sup> and six from Europe.<sup>10,65,66,68,70,71</sup> None of the studies had unclear assessments of obesity.

## Discussion

It is known that hypertension and obesity are common among patients with T2DM. This systematic review has captured data from observational studies from 36 countries around the world, demonstrating that the high prevalence of both obesity and hypertension is a worldwide issue. In this review, most of the studies reported hypertension rates above 60%, with rates even exceeding 75% in many of the studies. India,<sup>36,56–58</sup> Japan,<sup>1</sup> and Iran<sup>55</sup> were notable for having even their highest prevalence estimates below 50%, whereas Mexico,<sup>78</sup> Romania,<sup>75</sup> and Taiwan<sup>13,54</sup> had single or highest estimates just above 50% (Figure 2). Even for the countries with relatively low prevalence rates of hypertension in this review, the rates were consistent with higher hypertension rates among adults with diabetes<sup>102</sup> when compared with reports of general populations or adults without diabetes. In India, although the overall hypertension rate among patients with T2DM in the study by Tharkar et al<sup>58</sup> was 39%, the urban prevalence was 63.2% and the rural prevalence was 36.8%. Hypertension prevalence among adults from the general population in urban India ranges from 20% to 40% and in rural areas from 12% to 17%.<sup>103</sup> Therefore, the by-locality hypertension rates reported by Tharkar et al<sup>58</sup> are consistent with the expectation of hypertension rates that are 1.5 to 3.0 times higher in persons with T2DM than in those without diabetes.<sup>102</sup> Similarly, the hypertension rates among patients with T2DM were higher than rates reported for the general population in Iran,<sup>19,55</sup> Japan,<sup>1,19</sup> Mexico,<sup>78,104</sup> and Romania.<sup>75,105</sup>

Of the studies evaluating obesity prevalence in patients with T2DM, over one-quarter of the 32 rates based on BMI were above 50%, whereas over four-fifths of the rates estimated by waist circumference (Figure 4) were above 50%. The high prevalence of central obesity (high waist circumference) in most regions was observed despite the fact that only seven studies used waist circumference cut points as low as<sup>32,47,72,83,98</sup> or lower than<sup>47,98</sup> those recommended by the International Diabetes Federation (IDF) ( $\geq 80$  cm for women and  $\geq 94$  cm for men from Europe, Sub-Saharan Africa, Eastern Mediterranean, and Middle East;  $\geq 80$  cm

for women and  $\geq 90$  cm for men from South Asia, South and Central America, People's Republic of China, and Japan).<sup>106</sup> Therefore, the prevalence rates for central obesity are likely underestimates for many of the studies in this review.

The need for measuring both BMI and waist circumference in clinical practice is debated. Although waist circumference is a strong predictor of cardiometabolic risk, multiple expert organizations have agreed that adding this measure in the USA is unlikely to alter the management of obesity already defined by the gold-standard BMI.<sup>89</sup> They did note the value of assessing waist circumference changes in monitoring weight loss.<sup>89</sup> However, guidelines in India give BMI ( $> 25$  kg/m<sup>2</sup>) and waist circumference ( $> 90$  cm for men;  $> 80$  cm for women) equal importance in determining cardiometabolic risk and recommend that both should be measured.<sup>107</sup>

In this review, the ranges of prevalence rates for hypertension and obesity were broad for many of the regions and also globally. The variations may be due to patient selection methods and to sample sizes. For example, for hypertension prevalence, the particularly low estimate of 13.6% was found in a Saudi Arabian study in which the patients with T2DM were identified in a national screening program.<sup>45</sup> This contrasted with the 78.07% prevalence rate in another Saudi Arabian study that recruited patients from hospitals or clinics.<sup>46</sup> Further, the data in this review are the minimum and maximum prevalence rates reported by the studies, with no age or sample size adjustments.

## Strengths and limitations of this literature review

Risk of disease misclassification is a concern with studies that investigate prevalence rates. Although the verification of the disease states by a health care professional was not part of the inclusion criteria for this review, most of the studies in this review had this verification for T2DM, hypertension, and obesity. Very few of the observational studies in this review relied on patient self-report of T2DM, hypertension, or obesity.

This literature review study included only observational studies. In clinical trials, physicians may be biased to enroll patients in greater need of medical management – possibly increasing enrollment of patients with hypertension compared with the general population of patients with T2DM. Further, clinical studies involve alterations in treatment and new interventions; therefore, the potential or perceived increased risk may limit the study to a subset of patients with T2DM.

Studies in this literature review were grouped geographically by country and continent. No study meeting the

inclusion criteria (see “Methods”) was excluded based on the country in which it was conducted. Prevalence data were obtained for all six of the well-populated continents. However, the interpretation of the findings in this review is limited by the lack of representation for some sizable populations. None of the studies identified was conducted in Russia, some of the highly populated regions in Southeast Asia, Canada, or most of the countries in South America and Africa. Some of the highest diabetes prevalence rates, ranging from 16.4% in Vanuatu to 25.7% in Kiribati, have been found in Pacific Island nations<sup>108</sup> not represented in this article. Russia has a high prevalence of diabetes (10.0% of the population, or 12.6 million persons),<sup>108</sup> hypertension (34.4% with blood pressure  $\geq 140/90$  mmHg or on antihypertensive medications),<sup>109</sup> and obesity (24.9% with BMI  $\geq 30$  kg/m<sup>2</sup>).<sup>110</sup> Few studies were identified for the People’s Republic of China, although it is the country with the largest number of patients with diabetes (90 million).<sup>108</sup>

This literature review focused on studies presenting separate prevalence data for patients with T2DM, apart from diabetes as a whole. This focus may explain some of the gaps in regional data because information on comorbidities is often gathered for patients with diabetes without regard to type. Another possible explanation for the gaps is that studies reporting the prevalence of hypertension or obesity incidental to non-epidemiologic research questions would not have been identified, because the search terms in this review identified studies indexed as having the epidemiology of hypertension or obesity as a major focus. In addition, this review included only studies reported in English. Although an update of the systematic literature review reported here is beyond the scope of the current article, an informal search of the electronic databases was conducted on August 2, 2013. This search identified potentially useful studies from countries already represented in the systematic review, including the People’s Republic of China,<sup>111–113</sup> and from four additional countries (Bangladesh,<sup>114</sup> the Congo,<sup>115</sup> Ghana,<sup>116</sup> and Morocco<sup>117</sup>) but still no studies from Russia or Canada.

## Unmet need

The unmet need for controlling hypertension and obesity among adults with T2DM is great. In the USA, over 40% of those with diabetes and hypertension have uncontrolled hypertension<sup>26</sup> even though the expenditure to treat diabetes in this country is the highest in the world.<sup>118</sup> Controlling obesity in persons with T2DM is especially challenging because obesity has been increasing over the last several

decades among all persons in all regions of the world, with most regions seeing dramatic increases.<sup>19</sup> The same factors increasing obesity among all persons are faced by the patients with T2DM as they try to reduce weight. The possible environmental factors include the increased availability of cheap, energy-dense, and highly palatable foods; better food distribution systems; and pervasive food marketing strategies – all coupled with decreased physical activity due in part to changes in work activity and transportation.<sup>119</sup> The challenge of controlling weight among persons with T2DM is likely to only continue because the rise in obesity is driving an increase in T2DM.<sup>21,120</sup> The number of persons with T2DM is expected to reach 552 million in 2030, owing to increasing prevalence in every country.<sup>108</sup>

Many of the strategies for control of hypertension and obesity can be used for persons with or without diabetes and regardless of type of diabetes, although a preference exists for including angiotensin-converting enzyme inhibitors in the treatment of persons with diabetes.<sup>18,121</sup> Treatment choices for T2DM are numerous<sup>20</sup> and have differing effects on weight and blood pressure.<sup>122</sup> Although long-term data that confirm the benefit of small reductions in weight or blood pressure are often lacking, antidiabetic therapies should – to the greatest possible extent, given patient needs – at least not worsen hypertension and obesity. However, the literature review presented in this article focused on prevalence only and does not support recommendations about specific weight-reducing or blood pressure-reducing therapies. Outcomes of prospective trials of antidiabetic agents that lead to weight and/or blood pressure reduction should help clarify the benefits of these effects.

## Conclusion

The prevalence rates of hypertension and obesity in patients with T2DM are high throughout the world. There is evidence of notable differences in these rates among countries/regions. Controlling hypertension and reducing obesity in these patients is important to limit the morbidity and costs for the health care systems derived from diabetic complications. Knowing the prevalence of these comorbidities is important for determining the size of the population that may benefit from strategies to reduce blood pressure and weight in addition to adequately controlling blood glucose.

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## Disclosure

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