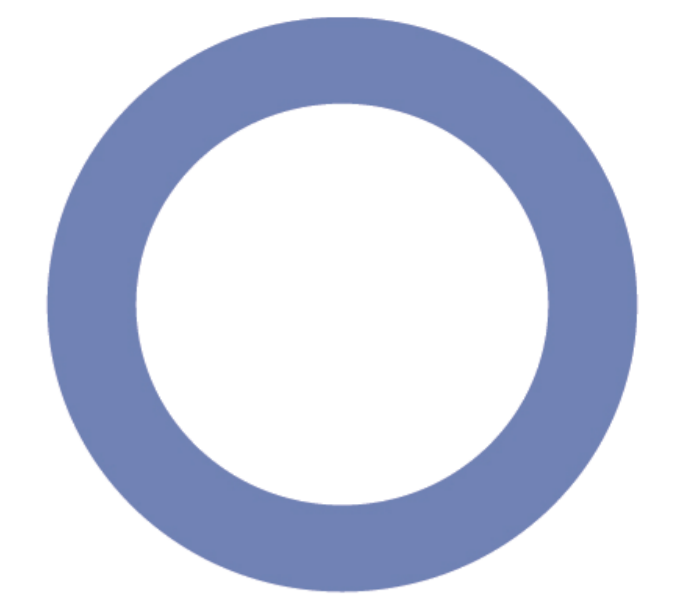


Global estimates of undiagnosed diabetes for the 2015 IDF Diabetes Atlas: a revision of the methodology



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Introduction

Type 2 diabetes may remain undetected for many years, during which time high blood glucose is silently damaging the body. This can lead to severe complications and increased healthcare costs. The earlier a person is diagnosed and management initiated, the better the chances of preventing or delaying harmful and costly complications.

In order to assist governments and IDF members to develop effective diabetes action plans, it is important to produce accurate estimates of the proportion of people with undiagnosed diabetes in each country.

In the 6th edition of the IDF Diabetes Atlas 2013, the same median undiagnosed diabetes percentage was used to estimate the proportion of undiagnosed diabetes for all countries within the same IDF region and income group (for example, all high-income countries in Europe).

For the 7th edition of the IDF Diabetes Atlas in 2015, a more refined methodology was developed that took into account the quality of the studies, the presence or absence of primary data on undiagnosed diabetes in each country, as well as the IDF region and World Bank income group classification.

Aim

To develop a new approach for estimating undiagnosed diabetes cases for the IDF Atlas 7th edition for 2015.

Methods

Population-based studies provide the basis for estimating undiagnosed diabetes. A group of people living in a particular area is tested for diabetes using a blood test, which identifies both known and previously undiagnosed cases. The IDF Diabetes Atlas estimates the proportion of undiagnosed diabetes in each country by using only high quality data sources that report the percentage of people with previously undiagnosed diabetes, and applies this to similar countries.

The estimation procedure included a data source selection procedure where appropriate studies were chosen using the Analytical Hierarchy Process that was established to give a quality score to all studies reporting undiagnosed cases. The highest quality scores were given to studies that were nationally-representative, based on oral-glucose-tolerance-tests, had at least 5,000 participants, and were conducted within the last 5 years.

The quality scores ranged from 0.09 (poor) to 0.59 (very good). The threshold for studies to enter the analysis was the median distribution of the scores (0.33) (Figure 1).

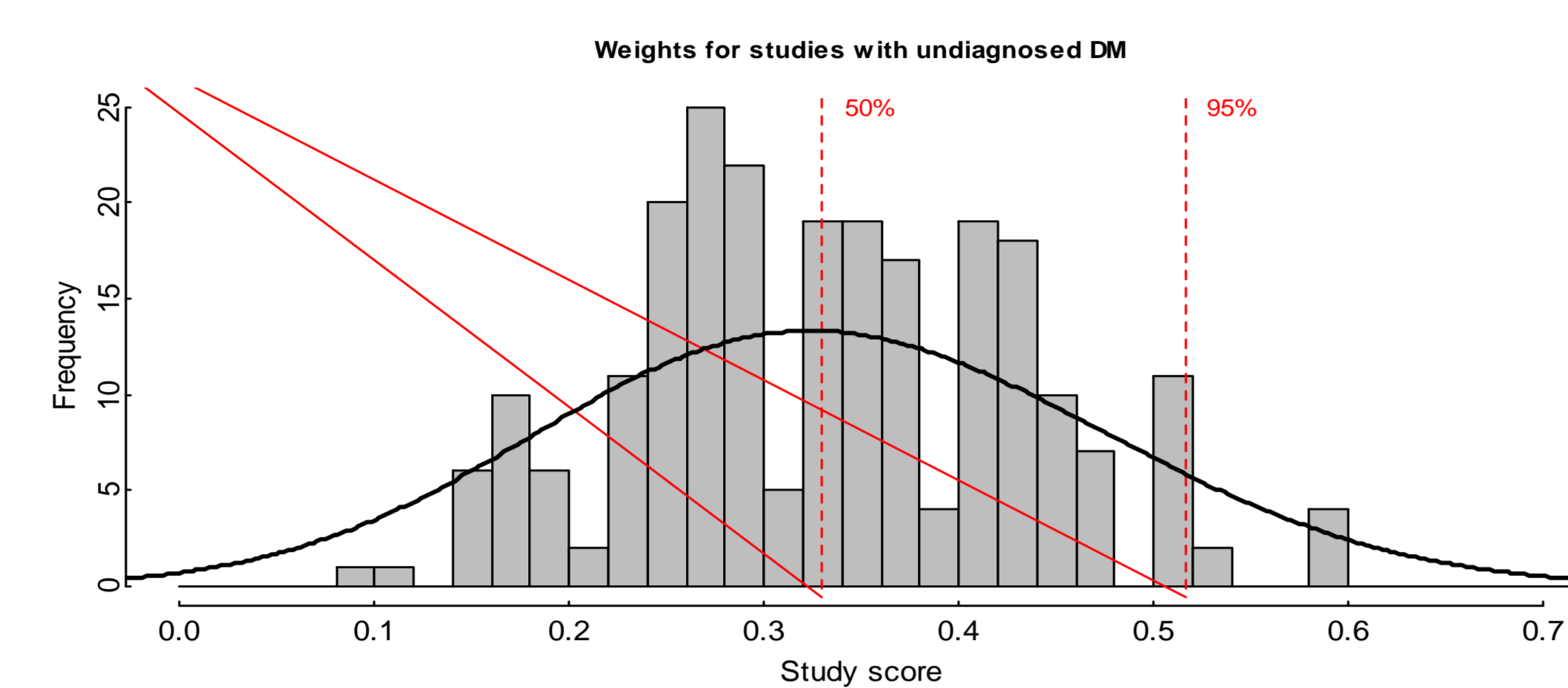


Figure 1. The distribution of quality scores for studies reporting undiagnosed diabetes. The density line (solid black) is based on the smoothing kernel and the bandwidth of 0.1. The quintiles at 50% and 95% are given as a dashed vertical lines.

From a total of 239 studies that reported undiagnosed diabetes (in 105 countries and territories, 48% of all 220 countries and territories) included in the set, 116 studies were selected, which covered 68 countries and territories (31% of 220) (Figure 2). The IDF regions with the lowest proportions of countries and territories with studies on undiagnosed diabetes selected were Africa (18% of 49) and North America & Caribbean (18% of 28).

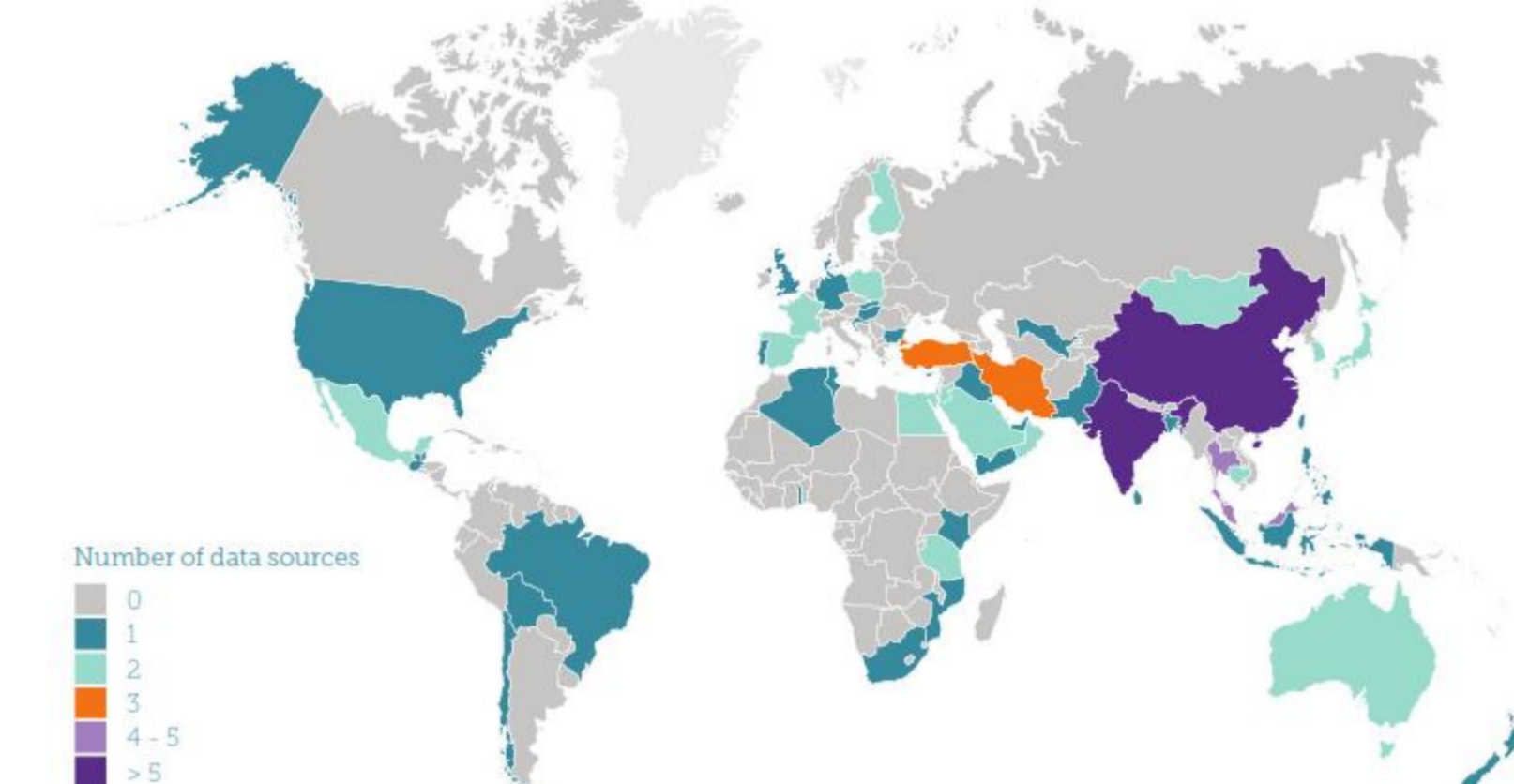


Figure 2. Countries and territories with selected data sources reporting the percentage of people with previously undiagnosed diabetes (20-79 years)

The set of rejected studies and the set of selected studies did not have significantly different proportions of people with undiagnosed diabetes (Figure 3, Welch Two Sample t-test, $p=0.087$), suggesting that the selection process did not introduce a bias in the results.

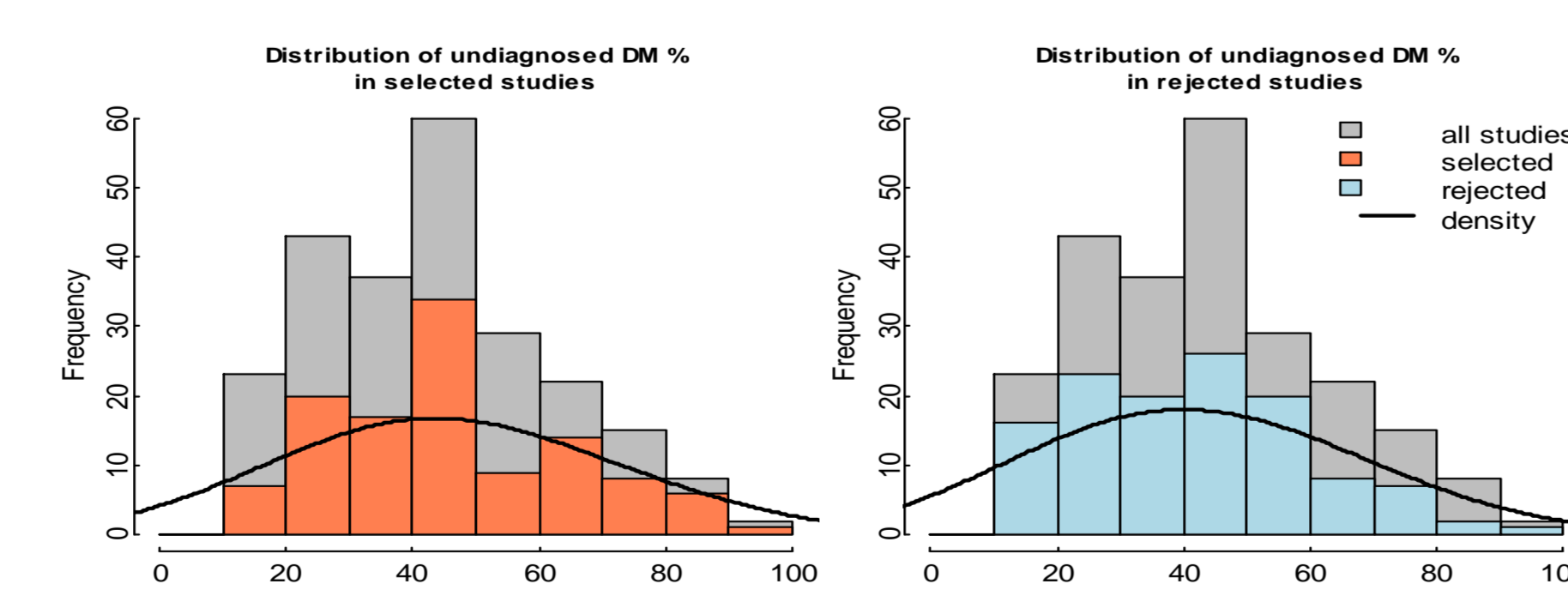


Figure 3. The distribution of undiagnosed diabetes percentage in the selected (left) and in the rejected (right) studies. The grey bars indicate the histogram for all studies and coloured bars show the histogram based on the subsets.

For the 7th edition of the IDF Diabetes Atlas in 2015, the regional-level, and World Bank income group-level effects on undiagnosed diabetes were estimated by a random-effect linear model, with weights corresponding to the quality score of the studies. The country-specific effect was generally assumed to be unknown and driven by latent variables to control for unobserved heterogeneity.

Countries were classified as being located in one of seven IDF regions – Africa, Europe, North America and the Caribbean, South-East Asia, South and Central America, Middle East and North Africa, or Western Pacific. The World Bank income group classifications of low-income countries, middle-income countries, and high-income countries were also included in the model.

IDF Region and World Bank income group characteristics had a significant association with the proportion of people with undiagnosed diabetes at a country level. Interestingly, adding the World Bank income group parameter to the model with IDF region parameter as a repressor didn't improve the model fit. However, the model containing both parameters was selected.

The final model estimated undiagnosed diabetes by using studies from that country (if applicable), as well as studies from countries within the same IDF Region and World Bank income group (Table 1), with weights corresponding to the quality score of the study.

	Model	Akaike df	information criterion*	Durbin-Watson test‡
1	undiag_pc ~ 1 + (1 country_id)	3	1005.21	2.225
2	undiag_pc ~ 1 + lmic_reg + (1 country_id)	5	998.36	2.16
3	undiag_pc ~ 1 + idf_reg + (1 country_id)	9	993.69	2.007
4	undiag_pc ~ 1 + idf_reg + lmic_reg + (1 country_id)	11	993.75	2.023

Table 1. The weighted random-effect linear models for estimating the proportion of people with undiagnosed diabetes in each country.

undiag_pc = percent of people with undiagnosed diabetes; idf_reg = IDF geographical region; lmic_reg = low-, middle-, high-income country; country_id = country identity; df = degrees of freedom.

*The Akaike information criterion was used to estimate the quality of each model, relative to each of the other models. Given a set of candidate models for the data, the preferred model is the one with the minimum Akaike information criterion value.

‡The Durbin-Watson test was used to check if the model was appropriate. The Durbin-Watson statistic ranges in value from 0 to 4. A value near 2 indicates non-autocorrelation; a value towards 0 indicates positive autocorrelation; a value towards 4 indicates negative autocorrelation.

Results

In sub-Saharan Africa, where resources are often lacking and governments may not prioritise screening for diabetes, the average proportion of people with diabetes who are undiagnosed was estimated at 66.7% (Figure 4). Even in high-income countries, about 35.8% of people with diabetes were not diagnosed. Globally, 46.5% of adults with diabetes (aged 20 to 79) were undiagnosed in 2015.

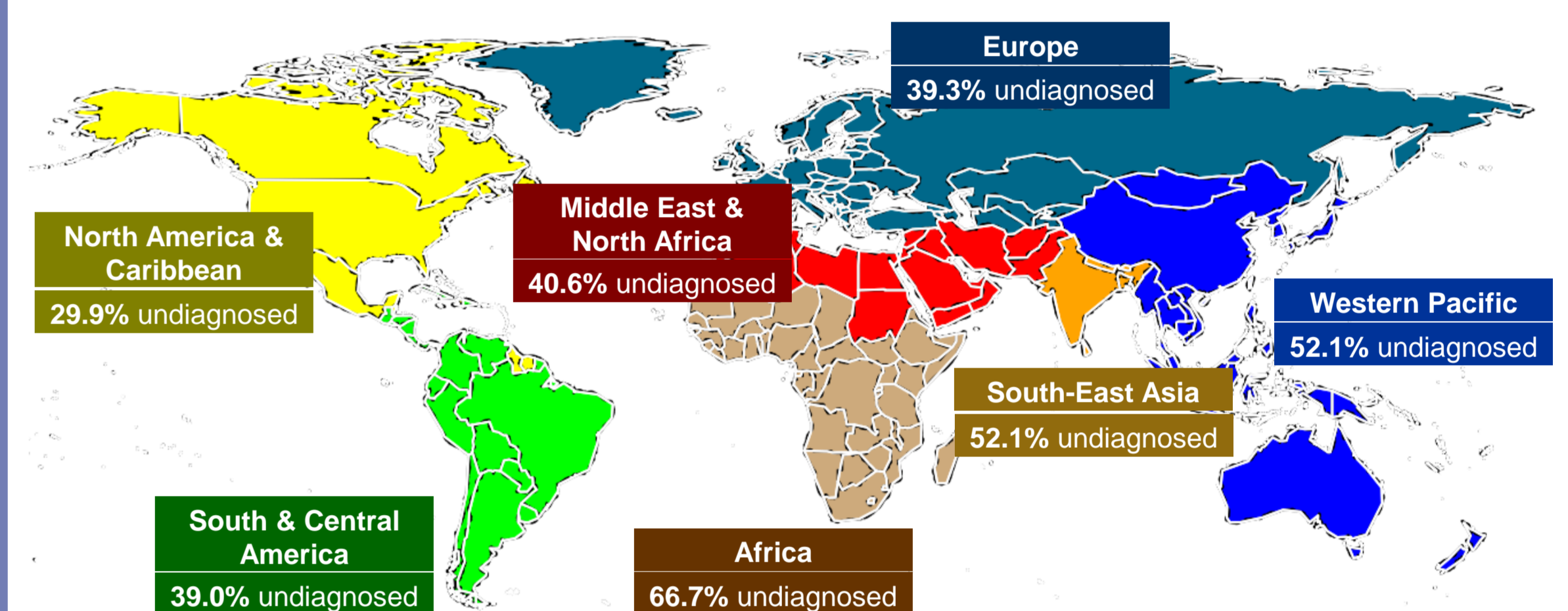


Figure 4. The estimated proportion of people (20-79 years) living with diabetes in each IDF region who were undiagnosed in 2015

Conclusion

It was been estimated by the International Diabetes Federation that globally 193 million (uncertainty range 158 – 252 million) people, or close to half (46.5%) of all people with diabetes, were unaware of their disease in 2015.

Globally, 81.1% of all people with diabetes who were undiagnosed were living in low- and middle-income countries. There is an urgent need to screen, diagnose and provide appropriate care to all people with diabetes.

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