Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants

*NCD Risk Factor Collaboration (NCD-RisC)**

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See **Comment** page 1349

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Summary

Background Underweight and severe and morbid obesity are associated with highly elevated risks of adverse health outcomes. We estimated trends in mean body-mass index (BMI), which characterises its population distribution, and in the prevalences of a complete set of BMI categories for adults in all countries.

Methods We analysed, with use of a consistent protocol, population-based studies that had measured height and weight in adults aged 18 years and older. We applied a Bayesian hierarchical model to these data to estimate trends from 1975 to 2014 in mean BMI and in the prevalences of BMI categories (<18·5 kg/m² [underweight], 18·5 kg/m² to <20 kg/m², 20 kg/m² to <25 kg/m², 25 kg/m² to <30 kg/m², 30 kg/m² to <35 kg/m², 35 kg/m² to <40 kg/m², ≥40 kg/m² [morbid obesity]), by sex in 200 countries and territories, organised in 21 regions. We calculated the posterior probability of meeting the target of halting by 2025 the rise in obesity at its 2010 levels, if post-2000 trends continue.

Findings We used 1698 population-based data sources, with more than 19·2 million adult participants (9·9 million men and 9·3 million women) in 186 of 200 countries for which estimates were made. Global age-standardised mean BMI increased from 21·7 kg/m² (95% credible interval 21·3–22·1) in 1975 to 24·2 kg/m² (24·0–24·4) in 2014 in men, and from 22·1 kg/m² (21·7–22·5) in 1975 to 24·4 kg/m² (24·2–24·6) in 2014 in women. Regional mean BMIs in 2014 for men ranged from 21·4 kg/m² in central Africa and south Asia to 29·2 kg/m² (28·6–29·8) in Polynesia and Micronesia; for women the range was from 21·8 kg/m² (21·4–22·3) in south Asia to 32·2 kg/m² (31·5–32·8) in Polynesia and Micronesia. Over these four decades, age-standardised global prevalence of underweight decreased from 13·8% (10·5–17·4) to 8·8% (7·4–10·3) in men and from 14·6% (11·6–17·9) to 9·7% (8·3–11·1) in women. South Asia had the highest prevalence of underweight in 2014, 23·4% (17·8–29·2) in men and 24·0% (18·9–29·3) in women. Age-standardised prevalence of obesity increased from 3·2% (2·4–4·1) in 1975 to 10·8% (9·7–12·0) in 2014 in men, and from 6·4% (5·1–7·8) to 14·9% (13·6–16·1) in women. 2·3% (2·0–2·7) of the world's men and 5·0% (4·4–5·6) of women were severely obese (ie, have BMI ≥35 kg/m²). Globally, prevalence of morbid obesity was 0·64% (0·46–0·86) in men and 1·6% (1·3–1·9) in women.

Interpretation If post-2000 trends continue, the probability of meeting the global obesity target is virtually zero. Rather, if these trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women; severe obesity will surpass 6% in men and 9% in women. Nonetheless, underweight remains prevalent in the world's poorest regions, especially in south Asia.

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Introduction

High body-mass index (BMI) is an important risk factor for cardiovascular and kidney diseases, diabetes, some cancers, and musculoskeletal disorders.[1–7] Concerns about the health and economic burden of increasing BMI have led to adiposity being included among the global non-communicable disease (NCD) targets, with a target of halting, by 2025, the rise in the prevalence of obesity at its 2010 level.[8,9] Information on whether countries are on track to achieve this target is needed to support accountability towards the global NCD commitments.[10]

Two previous studies[11–13] estimated global trends in the prevalence of overweight and obesity. However, the largest health benefits of weight management are achieved by shifting the population distribution of BMI. The only global report on mean BMI, which characterises distributional shifts, estimated trends to 2008,[11] before the global target was agreed. Epidemiological studies have shown substantial risks in people with very high BMI—eg, severe (≥35 kg/m²) or morbid (≥40 kg/m²) obesity.[14] Being underweight is also associated with increased risk of morbidity and mortality (ie, a so-called J-shaped association) and with adverse pregnancy outcomes.[4,6,15,16] Very few analyses of trends in underweight,[17] especially for men, and in severe and morbid obesity have been done. Finally, no information is available on the likelihood of individual countries or the world as a whole achieving the global obesity target.

We pooled population-based data to estimate trends from 1975 to 2014 in both mean BMI and in prevalence of

Research in context

Evidence before this study

We searched MEDLINE (via PubMed) for manuscripts published in any language between Jan 1, 1950, and March 12, 2013, using the search terms "body size"[mh:noexp] OR "body height"[mh:noexp] OR "body weight"[mh:noexp] OR "birth weight"[mh:noexp] OR "overweight"[mh:noexp] OR "obesity"[mh] OR "thinness"[mh:noexp] OR "Waist-Hip Ratio"[mh:noexp] or "Waist Circumference"[mh:noexp] or "body mass index" [mh:noexp]) AND ("Humans"[mh]) AND("1950"[PDAT] : "2013"[PDAT]) AND ("Health Surveys"[mh] OR "Epidemiological Monitoring"[mh] OR "Prevalence"[mh]) NOT Comment[ptyp] NOT Case Reports[ptyp]. Articles were screened according to the inclusion and exclusion criteria described in the appendix (pp 2–5).

The only global study on trends in mean body-mass index (BMI), which characterises shifts in the population distribution of BMI, reported trends to 2008 (before the global target on obesity was agreed) and no recent data are available. Two previous studies estimated global trends in the prevalence of overweight and obesity. Neither study reported trends in underweight, which is associated with increased risk of morbidity, mortality, and adverse pregnancy outcomes, or in high levels of BMI (eg, ≥35 or ≥40 kg/m²), which are associated with substantial risks of many non-communicable diseases.

Added value of this study

This study provides the longest and most complete picture of trends in adult BMI, including, for the first time, in underweight and severe and morbid obesity, which are of enormous clinical and public health interest. We were able to robustly depict this rich picture by reanalysing and pooling hundreds of population-based sources with measurements of height and weight according to a common protocol. We also systematically projected recent trends into the future, and assessed the probability of the global obesity target being achieved.

Implications of all the available evidence

The world has transitioned from an era when underweight prevalence was more than double that of obesity, to one in which more people are obese than underweight. However, underweight remains a public health problem in the world's poorest regions—namely south Asia and central and east Africa. If present trends continue, not only will the world not meet the global obesity target, but severe obesity will also surpass underweight in women by 2025.

BMI categories ranging from underweight to morbid obesity. We also estimated the probability of achieving the global obesity target.

Methods

Study design

We analysed population-based studies that had measured height and weight in adults aged 18 years and older with use of a consistent protocol. We estimated trends in mean BMI and prevalence of BMI categories (<18·5 kg/m² [underweight], 18·5 kg/m² to <20 kg/m², 20 kg/m² to <25 kg/m², 25 kg/m² to <30 kg/m², 30 kg/m² to <35 kg/m², 35 kg/m² to <40 kg/m², and ≥40 kg/m² [morbid obesity]) from 1975 to 2014, in 200 countries and territories. We report results for these categories, and for total obesity (BMI ≥30 kg/m²) and severe obesity (BMI ≥35 kg/m²). Countries and territories were organised into 21 regions, mostly on the basis of geography and national income (appendix pp 10, 11). The exception was a region consisting of high-income English-speaking countries because BMI and other cardiometabolic risk factors have similar trends in these countries, which can be distinct from other countries in their geographical region. Our analysis covered men and women aged 18 years and older, consistent with the Global Monitoring Framework for NCDs.[8]

See Online for appendix

Our study had two steps: first, we identified, accessed, and reanalysed population-based studies that had measured height and weight; then, we used a statistical model to estimate mean BMI and prevalences of BMI categories for all countries and years.

Data sources

We used multiple routes for identifying and accessing data, including from publicly available sources and through requests to various national and international organisations, as described in the appendix (pp 2–5). We used data sources that were representative of a national, subnational, or community population and had measured height and weight. We did not use self-reported height and weight because they are subject to biases that vary by geography, time, age, sex, and socioeconomic characteristics.[18–20] Because of these variations, present approaches to correcting self-reported data leave residual bias and error. Our data inclusion and exclusion criteria were designed to ensure population representativeness (appendix pp 2–5).

Statistical analysis

The statistical method is described in a statistical paper[21] and in the appendix of a previous paper.[22] In summary, the model had a hierarchical structure in which estimates for each country and year were informed by the country and year's own data, if available, and by data from other years in the same country and in other countries, especially those in the same region with data for similar time periods. The hierarchical structure shares information to a greater degree when data are non-existent or weakly informative (eg, have a small sample size or are not national), and to a lesser extent in data-rich countries and regions.

The model incorporated non-linear time trends and age patterns; national versus subnational and community representativeness; and whether data covered both rural and urban areas versus only one of them. The model also included covariates that help predict BMI, including national income (natural logarithm of per-person gross domestic product adjusted for inflation and purchasing power), proportion of population living in urban areas, mean number of years of education, and summary measures of availability of different food types for human consumption as described elsewhere.[23,24] We also did an analysis without the use of covariates and compared the estimates with and without covariates. Estimates with and without covariates were virtually identical in most countries (appendix pp 147,148) with the exception of a few countries that had no data and whose covariates (eg, national income) differed from those of their region (eg, Brunei, Bermuda, and North Korea). We report estimates for the model with covariates because it had better fit to data, as measured by the deviance information criterion.

We analysed mean BMI and each prevalence of a BMI category separately. We rescaled the estimated prevalence of different categories so that their sum was 1·0 in each age, sex, country, and year. The mean scaling factor across draws was 1·05 for men and 1·07 for women—ie, the sum of each separately estimated prevalence was close to 1·0. Estimates for regions and the world were calculated as population-weighted means of the constituent country estimates by age group and sex. For presentation, we age-standardised each estimated mean and prevalence to the WHO standard population,[25] by taking weighted means of age–sex-specific estimates, with use of age weights from the standard population. We tested how well our statistical model predicted mean BMI and the prevalence of each BMI category when a country-year did not have data as described in the appendix (pp 8,9), which showed that it performed very well in terms of its prediction validity.

We estimated mean change in BMI (absolute change for mean BMI and relative change for prevalence of BMI categories) over the 40 years of analysis, which we report as change per decade. We also report the posterior probability that an estimated increase or decrease in mean BMI or prevalence of a BMI category represented a truly increasing or decreasing trend. Additionally, we made separate estimates of change for pre-2000 and post-2000 years to assess whether the increasing recognition of adiposity as an "epidemic" in the 1990s,[26] and the subsequent public health attention and response,[27,28] might have slowed down its rise. Finally, we calculated the posterior probability of meeting the global obesity target if post-2000 trends continue.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. MDC, JB, and Country and Regional Data Group members had full access to the data in the study and the corresponding author had final responsibility for the decision to submit for publication.

Results

We accessed and used 1698 population-based data sources, with more than 19·2 million participants (9·9 million men and 9·3 million women) aged 18 years or older whose height and weight had been measured, in 186 of 200 countries for which estimates were made (appendix pp 143, 144); these 186 countries covered 99% of the world's population. 159 countries had at least two data sources, which allowed more reliable trend estimates. 827 sources (49%) were national, 236 (14%) were subnational, and the remaining 635 (37%) were community-based (appendix pp 145, 146). The mean number of data sources per country varied between regions from 2·8 data sources in Polynesia and Micronesia to 34·7 data sources in high-income Asia Pacific. 525 data sources (31%) were from years before 1995 and another 1173 (69%) data sources from 1995 and later. 1314 (77%) sources had data on men and women, 144 (8%) only on men, and 240 (14%) only on women.

Global age-standardised mean BMI in men increased from 21·7 kg/m² (95% CrI 21·3–22·1) in 1975 to 24·2 kg/m² (24·0–24·4) in 2014, and in women from 22·1 kg/m² (21·7–22·5) in 1975 to 24·4 kg/m² (24·2–24·6) in 2014 (figure 1); the posterior probability that the observed trends were true increases was greater than 0·9999 for both sexes. The mean increases of 0·63 kg/m² per decade (0·53–0·73) for men and 0·59 kg/m² per decade (0·49–0·70) for women are equivalent to the world's population having become on average more than 1·5 kg heavier each decade.

Regional mean BMI in 2014 in men ranged from 21·4 kg/m² in central Africa and south Asia to 29·2 kg/m² (95% CrI 28·6–29·8) in Polynesia and Micronesia (figure 1). In women, the range was from 21·8 kg/m² (21·4–22·3) in south Asia to 32·2 kg/m² (31·5–32·8) in Polynesia and Micronesia. Mean BMI was also high in men and women in high-income English-speaking countries, and in women in southern Africa and in the Middle East and north Africa.

The largest increase in men's mean BMI occurred in high-income English-speaking countries (1·00 kg/m² per decade; posterior probability >0·9999) and in women in central Latin America (1·27 kg/m² per decade; posterior probability >0·9999). The increase in women's mean BMI was also more than 1·00 kg/m² per decade in Melanesia, Polynesia and Micronesia, high-income English-speaking countries, southeast Asia, Andean Latin America, and the Caribbean. Because of these trends, men and women in high-income English-speaking countries in 2014 had substantially higher BMIs than those in continental Europe, whereas in 1975 their BMI had been similar or lower, especially for women (figure 1). By contrast with these large increases, the rise in women's mean BMI was less than 0·2 kg/m² per decade in central Europe, southwestern Europe, and high-income Asia Pacific.

In 1975, age-standardised mean BMI was less than 19 kg/m² in men in Timor-Leste, Burundi, India,

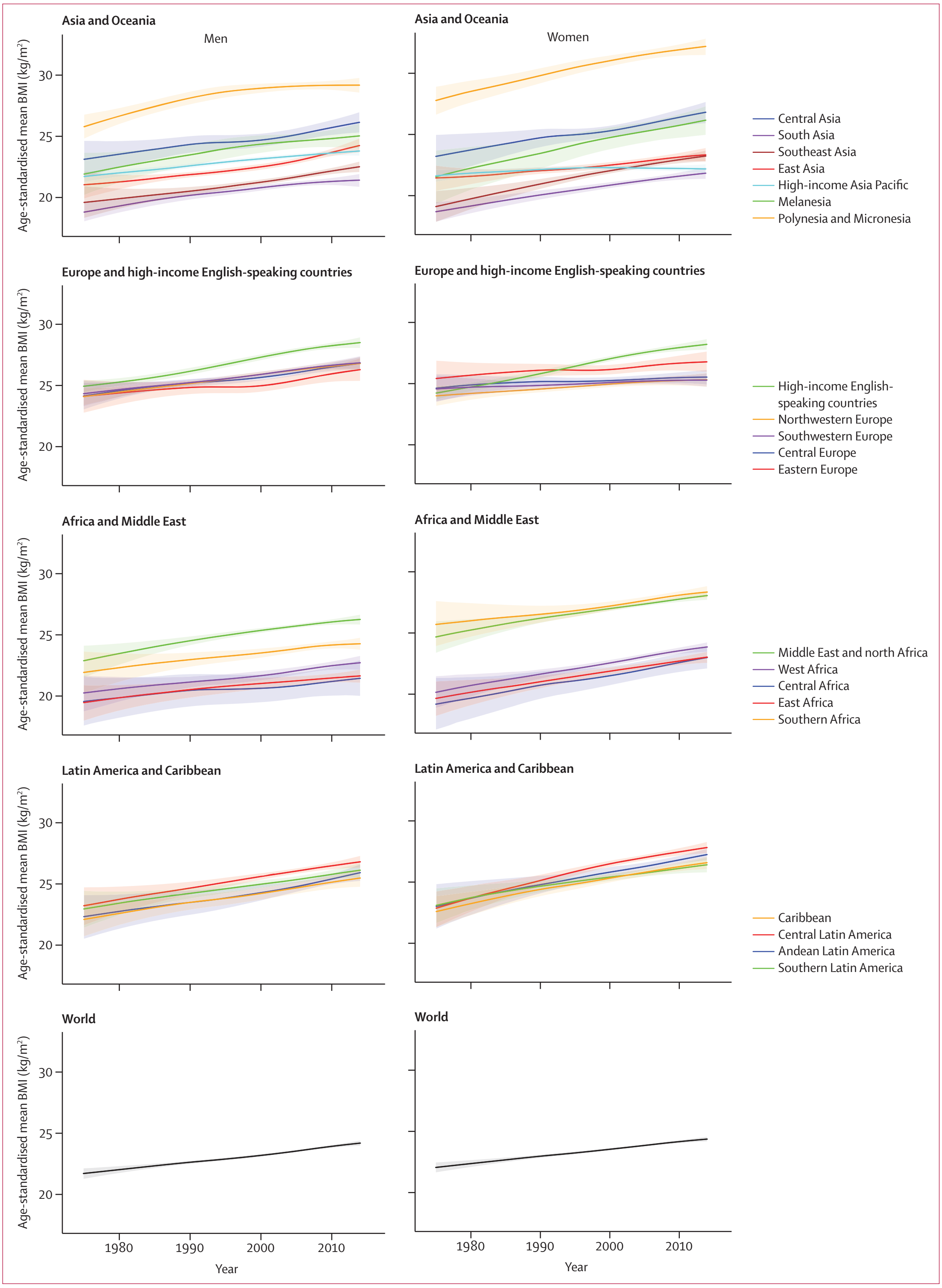


Figure 1: **Trends in age-standardised mean BMI by sex and region**
Lighter colours are 95% credible intervals. See appendix (pp 155–355) for results by sex and country. BMI=body-mass index.

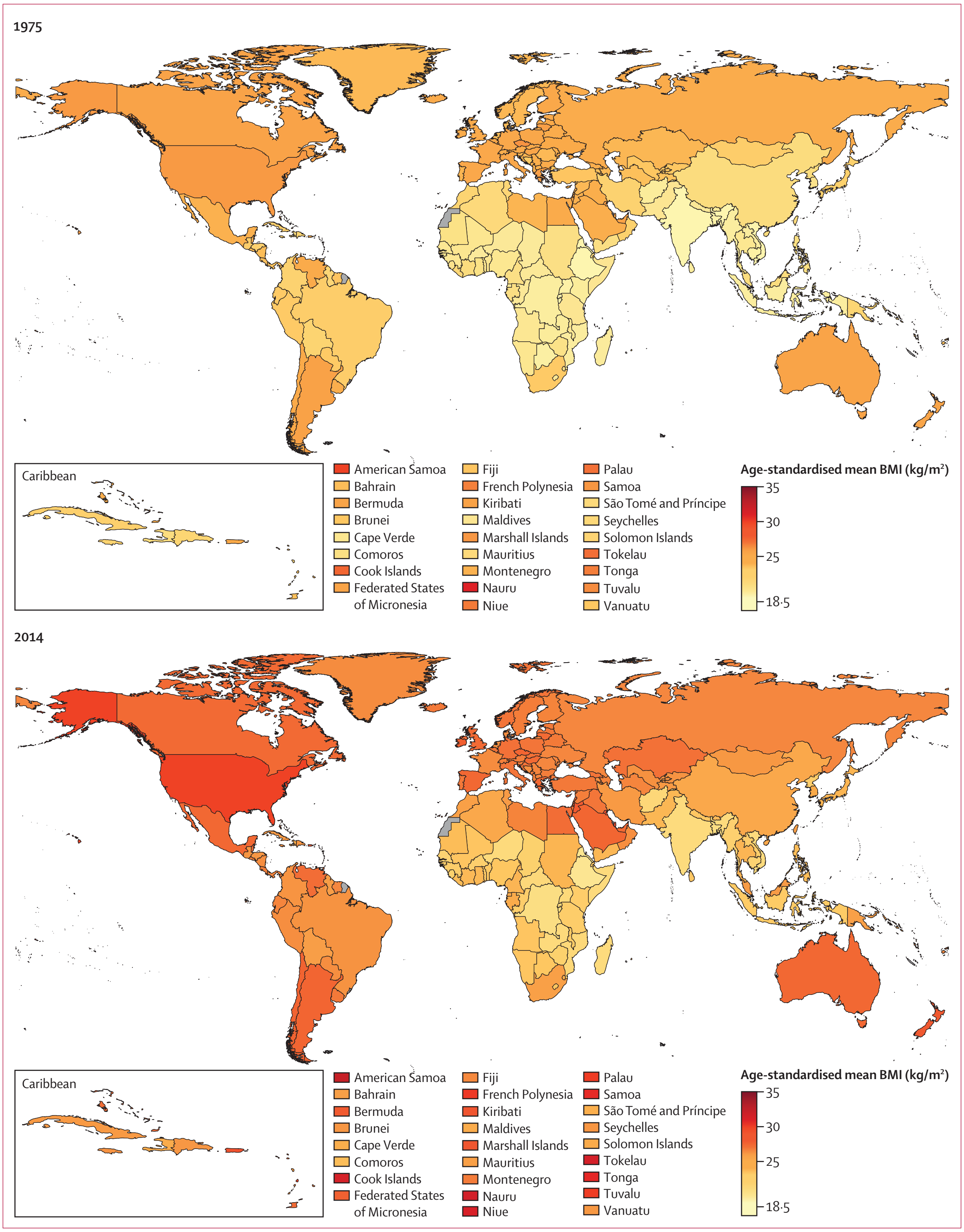


Figure 2: **Age-standardised mean BMI in men by country in 1975 and 2014**
See appendix (pp 56–64) for numerical results. BMI=body-mass index.

Ethiopia, Vietnam, Rwanda, Eritrea, and Bangladesh (figure 2), and 17–18 kg/m² in women in Bangladesh, Nepal, Timor-Leste, Burundi, Cambodia, and Vietnam (figure 3). In the same year, men and women in Nauru and women in American Samoa already had mean BMIs of more than 30 kg/m².[29,30] By 2014, age-standardised

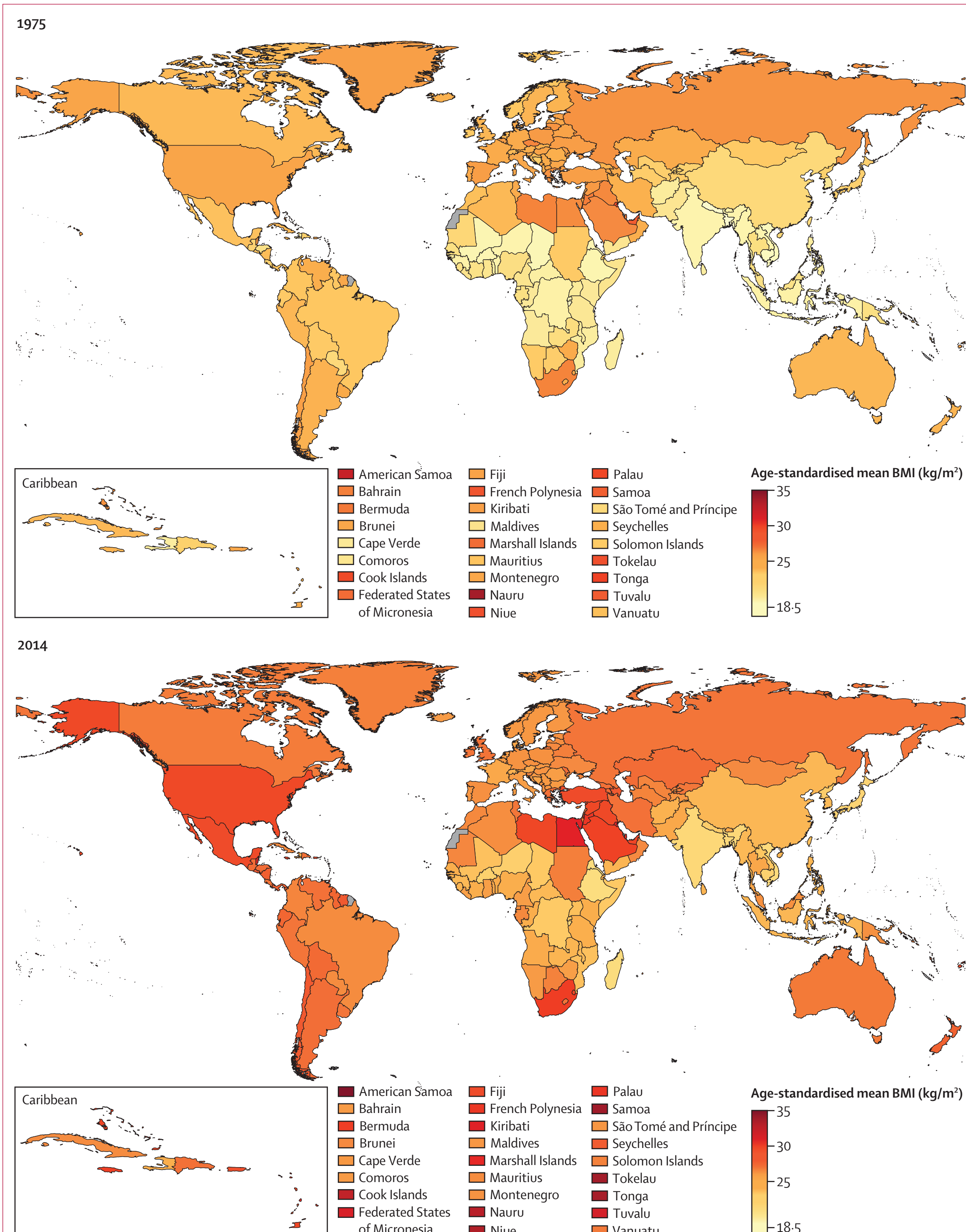


Figure 3: **Age-standardised mean BMI in women by country in 1975 and 2014**
See appendix (pp 56–64) for numerical results. BMI=body-mass index.

mean BMI was more than 20·0 kg/m² in men and more than 20·7 kg/m² in women in every country, with Ethiopia, Eritrea, and Timor-Leste having the lowest BMIs for both sexes. At the same time, in American Samoa, the age-standardised mean BMIs were 32·2 kg/m² (95% CrI 30·5–33·7) for men and

34·8 kg/m² (33·2–36·3) for women, with mean BMI also more than 30 kg/m² in both sexes in some other islands in Polynesia and Micronesia, and in women in some countries in the Middle East and north Africa (eg, Egypt and Kuwait) and the Caribbean.

From 1975 to 2014, trends in men's BMI ranged from virtually flat in Nauru (albeit at a very high level), North Korea, and several countries in sub-Saharan Africa, to an increase of more than 1·5 kg/m² per decade. Similarly, women's BMI did not change in Bahrain and Nauru (both starting at high BMIs), Singapore, Japan, North Korea, and several European countries, but increased by more than 1·5 kg/m² per decade in some countries. BMI increased more slowly after the year 2000 than in the preceding 25 years in Oceania and in most high-income countries for both sexes, and for women in most countries in Latin America and the Caribbean (figure 4). By contrast, the post-2000 increase was steeper than pre-2000 in men in central and eastern Europe, east and southeast Asia, and most countries in Latin America and the Caribbean. In other regions, increases in BMI before and after 2000 were similar or they had a mixture of slow-down and acceleration. The standard deviation of BMI also increased from 1975 to 2014 (appendix pp 149, 150), which contributed to an increase in the prevalence of people at either or both extremes of BMI.

Mean BMI in 2014 varied more across countries in women than it did in men. For example, the difference in women's mean BMI between American Samoa (the country with the highest mean BMI) and Timor-Leste (the country with the lowest mean BMI) was 14·1 kg/m² in 2014, which is equivalent to about a 35 kg difference in the mean weight per person, whereas in men, the difference in mean BMI was 12·1 kg/m², which is also equivalent to about a 35 kg difference in the mean weight per person (because men tend to be taller). Although male and female BMIs were correlated across countries, women on average had higher BMI than did men in 141 countries in 2014 (appendix pp 151, 152). The main exceptions from this sex pattern were countries in Europe and in high-income Asia Pacific and English-speaking countries. Changes in male and female BMI were weakly correlated across countries.

From 1975 to 2014, global age-standardised prevalence of underweight (BMI <18·5 kg/m²) decreased from 13·8% (95% CrI 10·5–17·4) to 8·8% (7·4–10·3) in men (figure 5) and from 14·6% (11·6–17·9) to 9·7% (8·3–11·1) in women (figure 6). Compared with the fall in underweight, prevalence of obesity (BMI ≥30 kg/m²) increased by a larger amount—from 3·2% (2·4–4·1) in 1975 to 10·8% (9·7–12·0) in 2014 in men, and from 6·4%

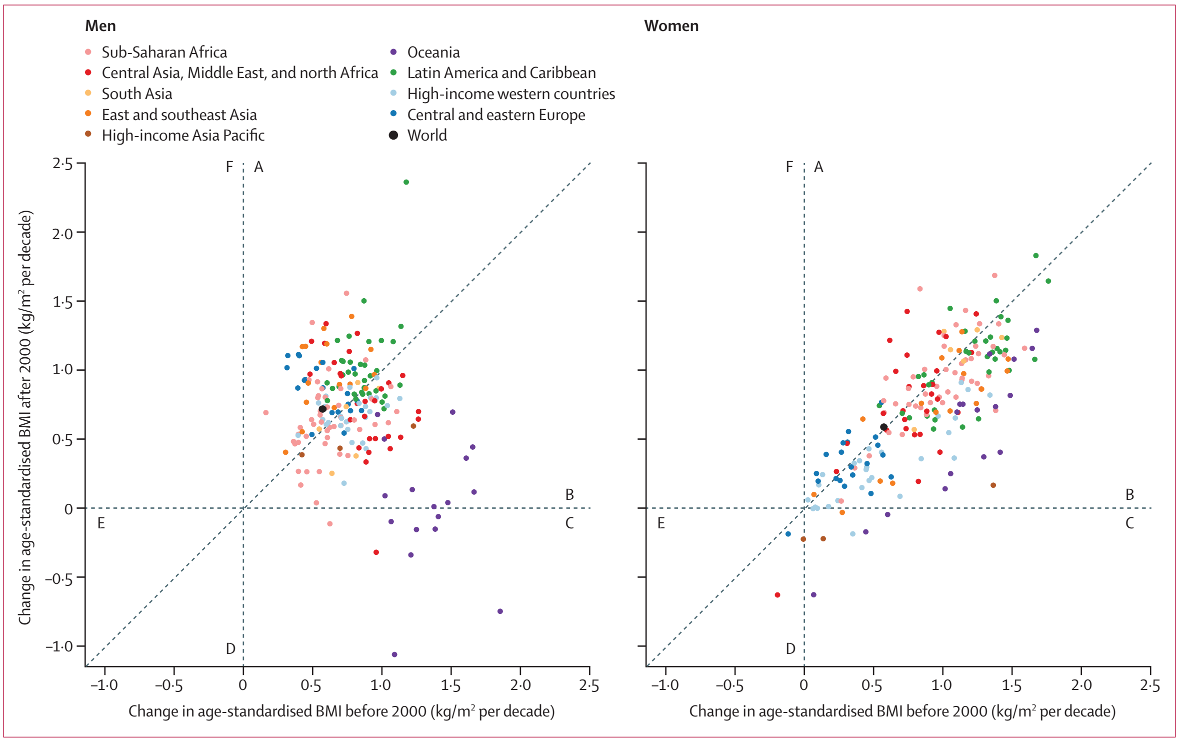


Figure 4: **Comparison of mean change in age-standardised mean BMI before and after the year 2000**
Each point represents one country. (A) countries in which mean BMI increased more rapidly after 2000 than it had before 2000. (B) countries in which mean BMI increased more slowly after 2000 than it had before 2000. (C) countries in which mean BMI increased before 2000 but decreased after 2000. (D) countries in which mean BMI decreased more rapidly after 2000 than it had before 2000. (E) countries in which mean BMI decreased more slowly after 2000 than it had before 2000. (F) countries in which BMI decreased before 2000 but increased after 2000. BMI=body-mass index.

(5·1–7·8) to 14·9% (13·6–16·1) in women. Prevalence of obesity surpassed that of underweight in 2004 in women and in 2011 in men. 2·3% (2·0–2·7) of the world's men and 5·0% (4·4–5·6) of women were severely obese in 2014. The global prevalence of morbid obesity (BMI ≥40 kg/m²) was 0·64% (0·46–0·86) in men and 1·6% (1·3–1·9) in women in 2014.

Age-standardised underweight prevalence in south Asia, where it is most common, decreased from more than 35% in both sexes in 1975 to 23·4% (95% CrI

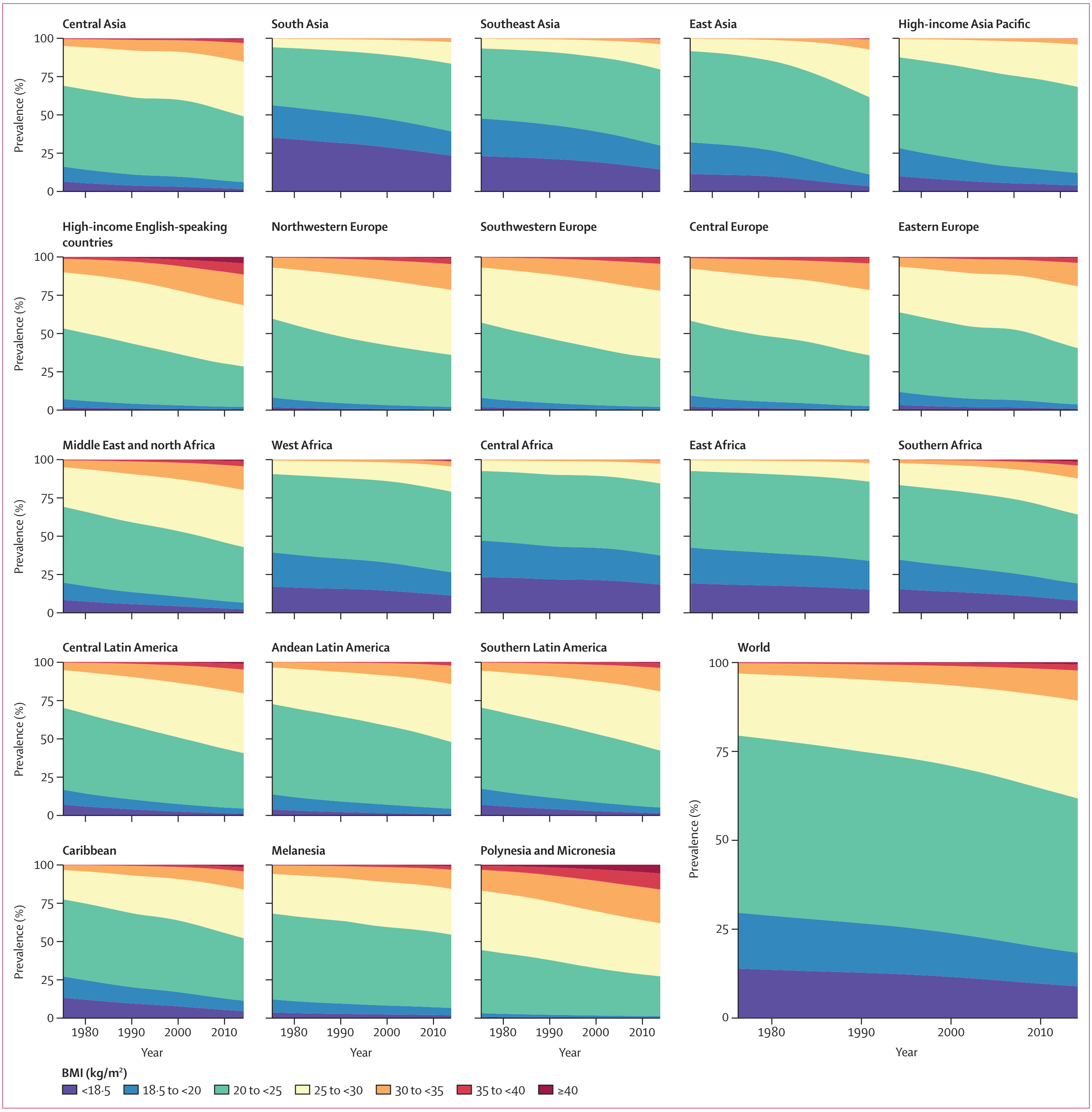


Figure 5: **Trends in age-standardised prevalence of BMI categories in men by region**
See appendix (pp 155–355) for results by country. BMI=body-mass index.

17·8–29·2) in men and 24·0% (18·9–29·3) in women in 2014 (figures 5, 6). Underweight prevalence also remained higher than 12% in women and higher than 15% in men in central and east Africa in 2014, despite some reductions. At the other extreme, more than 38% of men and more than 50% of women in Polynesia and Micronesia were obese in 2014. Obesity prevalence also surpassed 30% in men and women in high-income English-speaking countries, and in women in southern Africa and in the Middle East and north Africa.

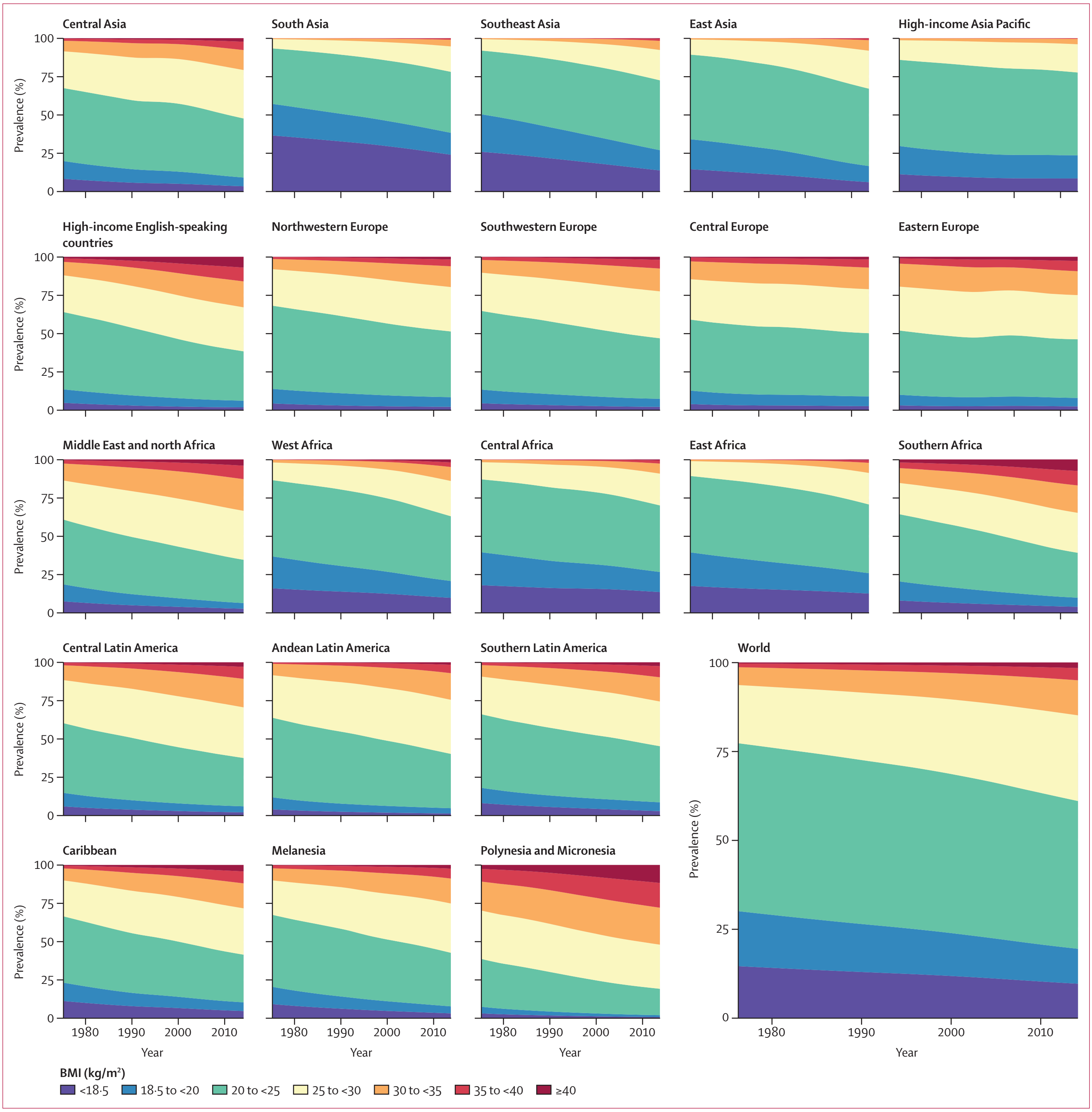
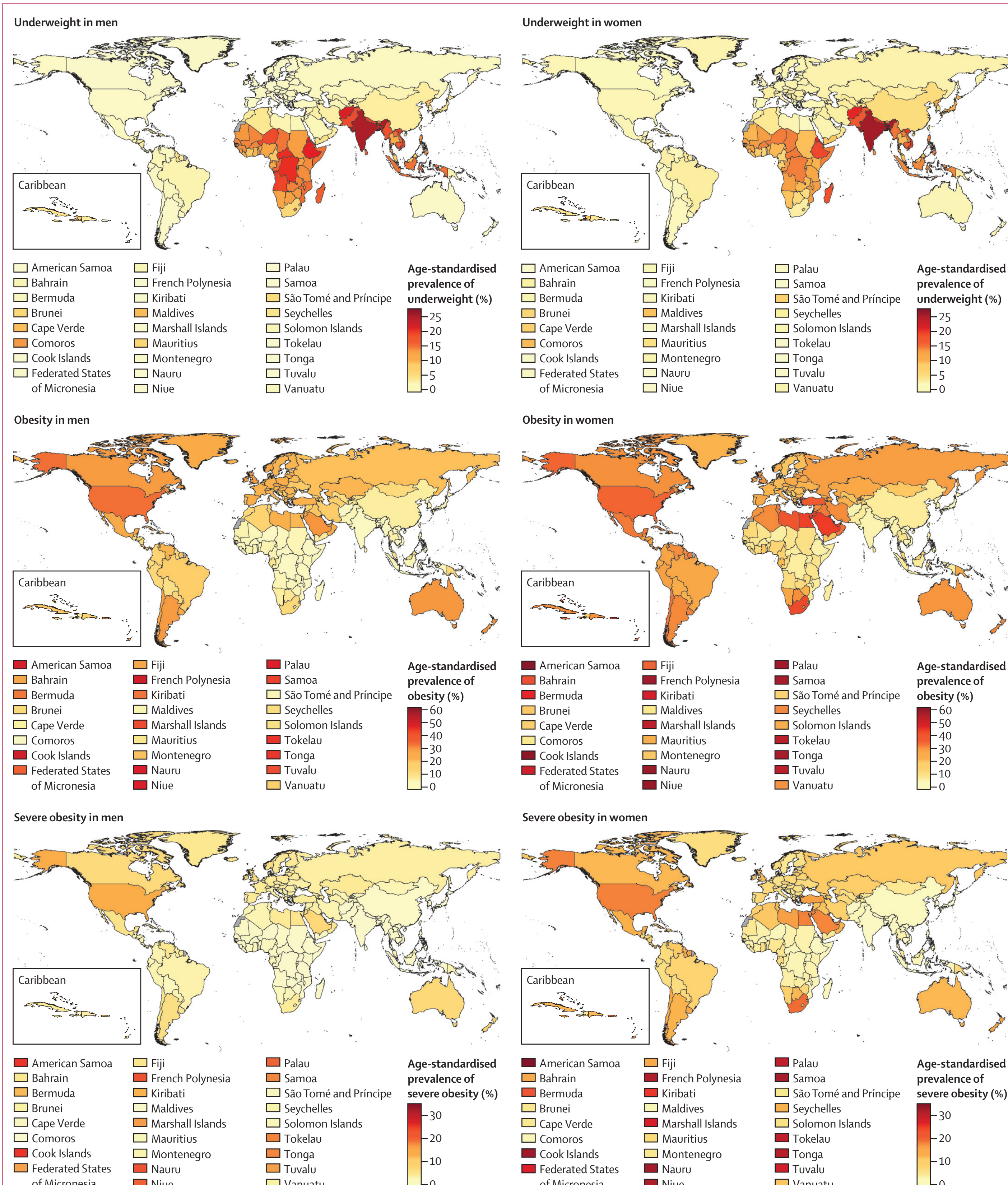


Figure 6: **Trends in age-standardised prevalence of BMI categories in women by region**
See appendix (pp 155–355) for results by country. BMI=body-mass index.


Underweight in men
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
Seychelles
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Age-standardised prevalence of underweight (%)
25
20
15
10
5
0
Underweight in women
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
Seychelles
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Age-standardised prevalence of underweight (%)
25
20
15
10
5
0
Obesity in men
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
Seychelles
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Age-standardised prevalence of obesity (%)
60
50
40
30
20
10
0
Obesity in women
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
Seychelles
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Age-standardised prevalence of obesity (%)
60
50
40
30
20
10
0
Severe obesity in men
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
Seychelles
Solomon Islands
Tokelau
Tonga
Tuvalu
Vanuatu
Age-standardised prevalence of severe obesity (%)
30
20
10
0
Severe obesity in women
Caribbean
American Samoa
Bahrain
Bermuda
Brunei
Cape Verde
Comoros
Cook Islands
Federated States of Micronesia
Fiji
French Polynesia
Kiribati
Maldives
Marshall Islands
Mauritius
Montenegro
Nauru
Niue
Palau
Samoa
São Tomé and Príncipe
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Age-standardised prevalence of severe obesity (%)
30
20
10
0

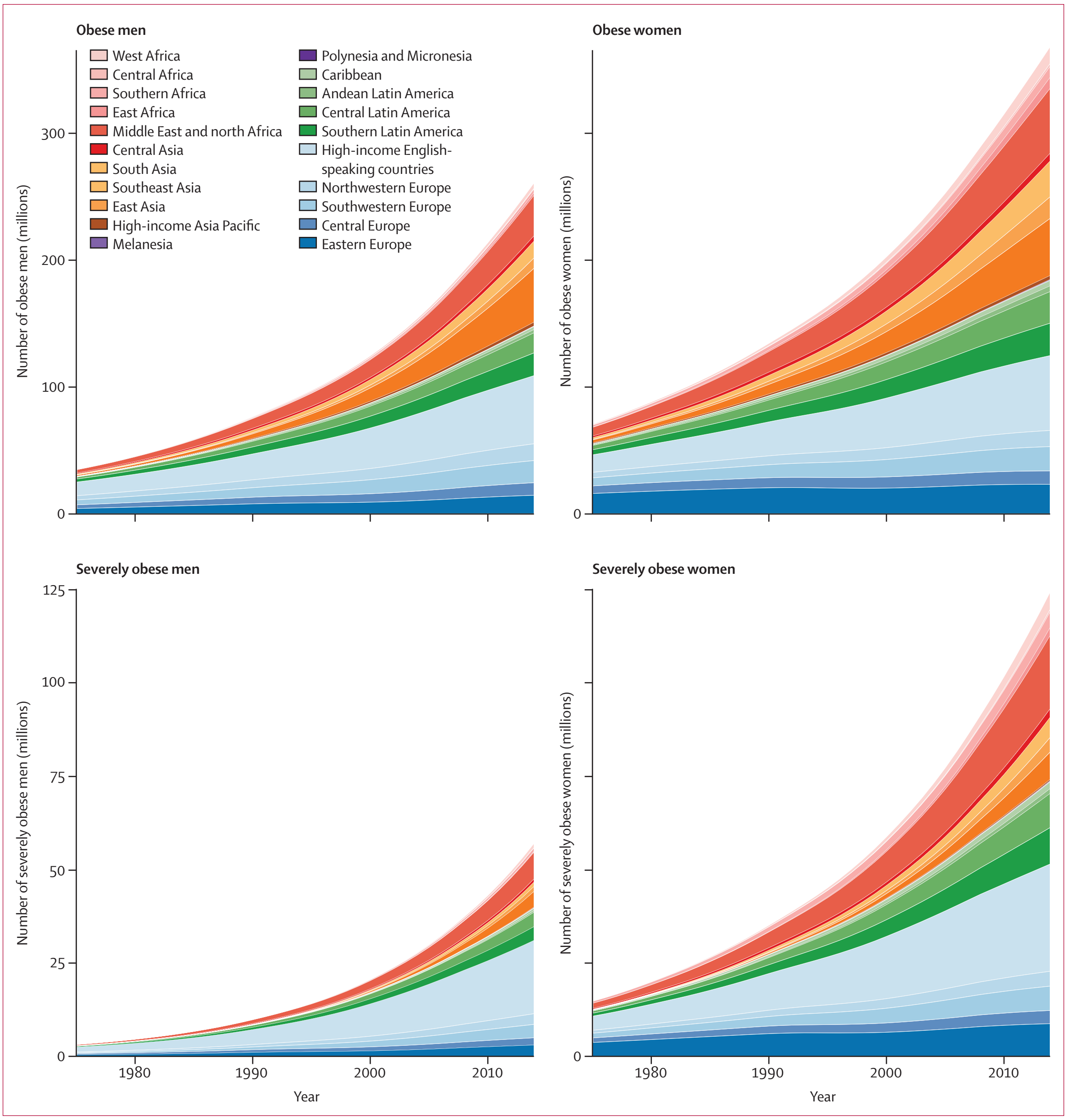

Figure 8: **Trends in the number of obese and severely obese people by region**
A person is obese if they have a body-mass index (BMI) of 30 kg/m² or higher, or is severely obese if they have a BMI of 35 kg/m² or higher.

Age-standardised prevalence of underweight in 2014 was less than 1% in men in 68 countries and in women in 11 countries (figure 7). At the other extreme, more than 20% of men in India, Bangladesh, Timor-Leste, Afghanistan, Eritrea, and Ethiopia, and a quarter or more of women in Bangladesh and India are still underweight.

Figure 7: **Age-standardised prevalence of underweight, obesity, and severe obesity by sex and country in 2014**
Underweight (BMI <18·5 kg/m²); obesity (BMI ≥30 kg/m²); and severe obesity (BMI ≥35 kg/m²). See appendix (pp 65–107) for numerical results for all BMI ranges. BMI=body-mass index.

In 1975, the proportion had been as high as 37% in Indian and Bangladeshi women.

In 2014, more men were obese than underweight in 136 (68%) of 200 countries; in 113 of these countries, more men were severely obese than underweight. For women, obesity surpassed underweight in 165 (83%) countries and severe obesity surpassed underweight in 135 countries. Obesity prevalence was less than 1% in men in Burundi and Timor-Leste and 1–2% in another 15 countries in central, east, and west Africa and in south and southeast Asia. The lowest prevalences in women were in Timor-Leste, Japan,

Underweight in men

1975

Rank	Country	Millions of underweight men (% of global underweight)
1	India	61·4 (37·9)
2	China	29·6 (18·2)
3	Indonesia	7·4 (4·6)
4	Bangladesh	5·8 (3·6)
5	Pakistan	5·2 (3·2)
6	Japan	3·4 (2·1)
7	Vietnam	3·2 (2·0)
8	Nigeria	2·8 (1·7)
9	Brazil	2·7 (1·7)
10	Thailand	2·1 (1·3)
11	Philippines	1·9 (1·2)
13	Ethiopia	1·7 (1·1)
16	DR Congo	1·2 (0·8)

2014

Rank	Country	Millions of underweight men (% of global underweight)
1	India	101·8 (46·2)
2	China	18·0 (8·1)
3	Indonesia	11·9 (5·4)
4	Bangladesh	11·5 (5·2)
5	Pakistan	9·5 (4·3)
6	Vietnam	5·8 (2·6)
7	Nigeria	4·9 (2·2)
8	Ethiopia	4·9 (2·2)
9	Philippines	3·6 (1·6)
10	DR Congo	3·1 (1·4)
12	Thailand	2·6 (1·2)
13	Japan	2·4 (1·1)
18	Brazil	1·5 (0·7)

Underweight in women

1975

Rank	Country	Millions of underweight women (% of global underweight)
1	India	58·3 (33·4)
2	China	35·7 (20·5)
3	Indonesia	8·4 (4·8)
4	Bangladesh	6·1 (3·5)
5	Pakistan	4·4 (2·5)
6	Japan	4·4 (2·5)
7	Vietnam	4·0 (2·3)
8	USA	4·0 (2·3)
9	Brazil	3·1 (1·8)
10	Nigeria	2·7 (1·5)
11	Philippines	2·5 (1·4)
14	Ethiopia	1·7 (1·0)

2014

Rank	Country	Millions of underweight women (% of global underweight)
1	India	100·5 (41·6)
2	China	30·3 (12·6)
3	Bangladesh	13·1 (5·4)
4	Indonesia	11·2 (4·6)
5	Pakistan	8·9 (3·7)
6	Vietnam	6·5 (2·7)
7	Japan	5·7 (2·3)
8	Philippines	4·4 (1·8)
9	Ethiopia	4·3 (1·8)
10	Nigeria	4·2 (1·7)
13	Brazil	2·5 (1·0)
15	USA	2·1 (0·9)

Obesity in men

1975

Rank	Country	Millions of obese men (% of global obesity)
1	USA	7·7 (22·5)
2	Russia	2·5 (7·4)
3	Germany	2·0 (5·9)
4	UK	1·7 (5·1)
5	France	1·4 (4·0)
6	Italy	1·4 (4·0)
7	Ukraine	1·0 (2·9)
8	Poland	0·9 (2·7)
9	Argentina	0·9 (2·7)
10	Brazil	0·9 (2·6)
12	Mexico	0·8 (2·3)
13	China	0·7 (2·1)
19	India	0·4 (1·3)

2014

Rank	Country	Millions of obese men (% of global obesity)
1	China	43·2 (16·3)
2	USA	41·7 (15·7)
3	Brazil	11·9 (4·5)
4	Russia	10·7 (4·0)
5	India	9·8 (3·7)
6	Mexico	8·9 (3·3)
7	Germany	8·3 (3·1)
8	UK	6·8 (2·6)
9	Italy	5·8 (2·2)
10	France	5·6 (2·1)
16	Argentina	3·8 (1·4)
17	Poland	3·6 (1·4)
19	Ukraine	3·1 (1·1)

Obesity in women

1975

Rank	Country	Millions of obese women (% of global obesity)
1	Russia	12·0 (17·0)
2	USA	10·5 (14·8)
3	Ukraine	3·7 (5·3)
4	Germany	3·1 (4·3)
5	Italy	2·4 (3·4)
6	UK	2·1 (3·0)
7	Poland	2·1 (3·0)
8	France	2·1 (2·9)
9	Brazil	1·9 (2·6)
10	China	1·7 (2·5)
11	Mexico	1·7 (2·4)
12	Egypt	1·5 (2·1)
14	Turkey	1·3 (1·8)
18	Iran	0·9 (1·3)
19	India	0·8 (1·2)

2014

Rank	Country	Millions of obese women (% of global obesity)
1	China	46·4 (12·4)
2	USA	46·1 (12·3)
3	India	20·0 (5·3)
4	Russia	18·7 (5·0)
5	Brazil	18·0 (4·8)
6	Mexico	13·9 (3·7)
7	Egypt	10·2 (2·7)
8	Turkey	9·9 (2·6)
9	Germany	8·5 (2·3)
10	Iran	8·0 (2·1)
11	UK	7·7 (2·1)
14	Italy	6·7 (1·8)
15	France	6·3 (1·7)
18	Ukraine	5·0 (1·3)
21	Poland	4·3 (1·1)

Severe obesity in men

1975

Rank	Country	Millions of severely obese men (% of global severe obesity)
1	USA	1·1 (34·7)
2	Russia	0·2 (7·0)
3	Germany	0·1 (4·4)
4	UK	0·1 (4·2)
5	Poland	0·1 (3·7)
6	Ukraine	0·1 (3·2)
7	Argentina	0·1 (2·9)
8	France	0·1 (2·8)
9	Italy	0·1 (2·4)
10	Egypt	0·1 (2·2)
11	Mexico	0·1 (2·2)
12	Canada	0·1 (1·8)
15	Brazil	<0·1 (1·5)
60	China	<0·1 (0·2)

2014

Rank	Country	Millions of severely obese men (% of global severe obesity)
1	USA	16·2 (27·8)
2	China	4·3 (7·4)
3	Mexico	2·4 (4·1)
4	Russia	2·2 (3·8)
5	Brazil	2·2 (3·8)
6	UK	1·9 (3·2)
7	Germany	1·8 (3·1)
8	Egypt	1·5 (2·6)
9	France	1·2 (2·1)
10	Canada	1·2 (2·0)
12	Italy	1·0 (1·8)
15	Argentina	1·0 (1·7)
17	Poland	0·8 (1·3)
22	Ukraine	0·6 (1·1)

Severe obesity in women

1975

Rank	Country	Millions of severely obese women (% of global severe obesity)
1	USA	3·0 (20·4)
2	Russia	2·9 (19·7)
3	Ukraine	0·8 (5·4)
4	Germany	0·5 (3·7)
5	Poland	0·5 (3·2)
6	France	0·5 (3·2)
7	Italy	0·4 (3·0)
8	South Africa	0·4 (2·9)
9	UK	0·4 (2·8)
10	Egypt	0·3 (2·3)
11	Mexico	0·3 (2·0)
12	Brazil	0·3 (2·0)
15	Turkey	0·2 (1·6)
35	India	0·1 (0·4)
41	China	<0·1 (0·3)

2014

Rank	Country	Millions of severely obese women (% of global severe obesity)
1	USA	23·1 (18·3)
2	China	7·6 (6·1)
3	Russia	7·3 (5·8)
4	Brazil	6·7 (5·3)
5	Mexico	5·5 (4·4)
6	Egypt	4·5 (3·6)
7	Turkey	4·0 (3·2)
8	India	3·7 (2·9)
9	South Africa	3·4 (2·7)
10	UK	3·1 (2·5)
11	Germany	2·7 (2·2)
13	France	2·2 (1·8)
15	Italy	2·2 (1·7)
19	Ukraine	1·7 (1·4)
20	Poland	1·5 (1·2)

Vietnam, North Korea, Cambodia, Laos, and Bangladesh, all less than 5%. At the other extreme, more than 45% of men in six island nations in Polynesia and Micronesia, and more than 50% of women in 11 such island nations were obese. The prevalence of obesity in women in several Caribbean and Middle Eastern countries was 40–50%. Severe obesity surpassed 20% in men and 30% in women in some Polynesian and Micronesian islands, reaching 33·4% (95% CrI 23·6–43·5) in American Samoa in 2014. More than 15% of women in Nauru and American Samoa were morbidly obese.

In 2014, about 266 million men (95% CrI 240–295 million) and 375 million women (344–407 million) were obese in the world, compared with 34 million men (26–44 million) and 71 million women (57–87 million) in 1975 (figure 8). 58 million (49–68 million) of these men and 126 million (112–141 million) of these women were severely obese in 2014. 18·4% of the world's obese adults (118 million) lived in high-income English-speaking countries and these countries contained an even larger share of the world's severely obese people (27·1%; 50 million), followed by 13·9% (26 million) in the Middle East and north Africa.

Countries where large numbers of underweight people lived in 1975 and in 2014 were mostly large countries in Asia and sub-Saharan Africa, with an increasing share of underweight people living in south Asia over time (figure 9). By contrast with this stability of underweight geography, countries with the largest number of obese and severely obese people changed over these four decades, with more middle-income countries joining the USA, especially for women. In 2014, slightly more obese men and women lived in China than in the USA, and even for severe obesity, China moved from 60th place for men and 41st place for women in 1975, to 2nd rank for both men and women in 2014. Nonetheless, more than one in four severely obese men and almost one in five severely obese women in the world still live in the USA.

If post-2000 trends continue, every country has a less than 50% probability of meeting the global obesity target, with Nauru having the highest probability of about 45% (appendix pp 153, 154). The probability of achieving the target is less than 10% for men in 194 countries, and for women in 174 countries. At the global level, the probability of meeting the target is virtually zero. Rather, if present trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women; severe obesity will surpass 9% in women and 6% in men, and will be larger than the projected prevalence of underweight in women.

***Figure 9:* Ten countries with the largest number of underweight, obese, and severely obese men and women in 1975 and 2014**

Colours for each country indicate its region, using the same colour scheme as in figure 4. Underweight (BMI <18·5 kg/m^2); obesity (BMI ≥30 kg/m^2); and severe obesity (BMI ≥35 kg/m^2). BMI=body-mass index.

Discussion

Over the past four decades, we have transitioned from a world in which underweight prevalence was more than double that of obesity, to one in which more people are obese than underweight, both globally and in all regions except parts of sub-Saharan Africa and Asia. The rate of increase in BMI since 2000 has been slower than in the preceding decades in high-income countries, where adiposity became an explicit public health concern around this time,[27,28] and in some middle-income countries. However, because the rate of BMI increase has accelerated in some other regions, the global increase in BMI has not slowed down. If post-2000 trends continue, not only will the world not meet the global target for halting the increase in obesity, but also severe obesity will surpass underweight in women by 2025. Nonetheless, underweight remains a public health problem in south Asia and central and east Africa.

We estimated a slightly larger increase in mean BMI since 1980 than Finucane and colleagues did,[11] especially in men, because our estimates for 1980 were lower, globally and in most regions; this difference might be because our study included substantially more data, from a larger number of countries. Our global estimates of overweight prevalence are similar to those reported by Stevens and colleagues[13] for 2008, and by Ng and colleagues for 2013.[12] Our estimates for obesity for the same years are slightly lower than those of Stevens and colleagues and slightly higher than those of Ng and colleagues. Furthermore, we estimated a lower prevalence of obesity for 1980 than Ng and colleagues had, which means we have attributed a larger role to the rise over the past few decades for the present extent of obesity. Differences between our study and that of Ng and colleagues were greater at the regional level; for example, our estimates for obesity prevalence in men in south Asia and central, east, and west Africa were less than half of those by Ng and colleagues. None of these previous works had estimated underweight or severe and morbid obesity, which are important clinical and public health outcomes.

The strengths of our study include its unique scope of making consistent estimates of mean BMI and the prevalence of all BMI categories with clinical and public health relevance, including the first-ever estimates of underweight and severe and morbid obesity. These estimates helped reveal the details of the transition from underweight to overweight and obesity throughout the world. We also reported on the probability of each country meeting the global obesity target. We put great emphasis on data quality and used only population-based data sources that had measured height and weight to avoid the bias in self-reported data. Characteristics and quality of data sources were verified by Collaborating Group members (appendix pp 2–5). Data were analysed according to a common protocol to obtain the required mean and prevalence by age and sex, which in turn minimised reliance on models for filling such gaps, as done in previous studies.[11–13] Finally, we pooled data using a statistical model designed to take into account the epidemiological features of outcomes such as BMI, and one that used all available data while giving more weight to national data than subnational and community studies.

Despite our efforts in identifying and accessing country-level data, some countries had few data sources, especially those in Polynesia and Micronesia, the Caribbean, and central Asia. Additionally, only 42% of sources included people older than 70 years. In view of ageing trends throughout the world, older people should be included in health and nutrition surveys, which have traditionally focused on childbearing ages. Even measured height and weight data can have error depending on how closely measurement protocols are followed. Although data held by Collaborating Group members were analysed to provide all needed details by sex and age group and BMI level, individual participant data could not be accessed for 19·4% of data used in our analysis, hence conversions across categories were still needed; nonetheless, the conversion regressions had high predictive accuracy (appendix pp 41–55). A novel component of our study is that we estimated the prevalences of a complete set of BMI categories, but the uncertainty intervals for BMIs of 30 kg/m² or more and 35 kg/m² or more, prevalences that span more than one of the analysed categories, could be affected by the fact that we combined posterior distributions across Bayesian models. We did not estimate trends in measures of adiposity other than BMI, such as waist circumference and waist-to-hip ratio, because these were measured in less than half of all the data sources and their measurement became more common after the 1980s. A systematic review[31] of epidemiological studies reported that, taken together, studies that had measured BMI and either waist circumference or waist-to-hip ratio do not show that any of the measures of adiposity have "superior discriminatory capability" of adverse cardiometabolic outcomes; any reported difference was "too small to be of any clinical relevance". We did not analyse children and adolescents for two reasons. First, because childhood and adolescence is a period of rapid growth, BMI cutoffs used to define underweight, overweight, and obesity for children and adolescents are different from those for adults, and vary by age and sex.[32] Second, time trends in children's and adolescents' obesity are different from those of adults.[33]

Our results have several implications. First, the global focus on the obesity epidemic has largely overshadowed the persistence of underweight in some countries. Our results show the need to address the remaining underweight problem and by doing so reduce risks to pregnant women and their newborn infants,[15] mortality from tuberculosis and other respiratory diseases,[34] and possibly all-cause mortality, which has a J-shaped association.[2,3] To address this problem will require social and food policies that enhance food security in poor households, but also avoid overconsumption of processed carbohydrates and other unhealthy foods. Second, although adiposity has been consistently shown to be an independent risk factor for several NCDs in individual-level epidemiological studies, at the population level, the effect of rising BMI on the course of mortality reduction has so far been somewhat small in high-income countries,[35,36] possibly because pharmacological treatment has helped reduce blood pressure and serum cholesterol and manage diabetes complications, which are mediators of the effects of BMI on cardiovascular diseases. In low-income countries, where health systems might not have the capacity to identify and treat hypertension, dyslipidaemia, and diabetes, adiposity might have a larger effect on population health. Furthermore, we have shown that some high-income and middle-income regions are now facing an epidemic of severe obesity. Even anti-hypertensive drugs, statins, and glucose lowering drugs will not be able to fully address the hazards of such high BMI levels,[7] and bariatric surgery might be the most effective intervention for weight loss and disease prevention and remission.[37] However, long-term health outcomes of bariatric surgery are largely unknown and it is not accessible to most people in low-income and middle-income countries because of financial and health system barriers.

Present interventions and policies have not been able to stop the rise in BMI in most countries.[38–40] The global NCD target on obesity, although ambitious in view of past trends, has engendered a new look at policies that could slow down and stop the worldwide increase in BMI.[40–42] To avoid an epidemic of severe obesity, the next step must be to implement these policies, and to systematically assess their effect.[43]

Contributors

ME designed the study and oversaw research. Members of the Country and Regional Data Group collected and reanalysed data, and checked pooled data for accuracy of information about their study and other studies in their country. MDC and GAS led data collection and JB led the statistical analysis and prepared results. Members of the Pooled Analysis and Writing Group collated data, checked all data sources in consultation with the Country and Regional Data Group, analysed pooled data, and prepared results. ME wrote the first draft of the report with input from other members of Pooled Analysis and Writing Group. Members of Country and Regional Data Group commented on draft report.

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