

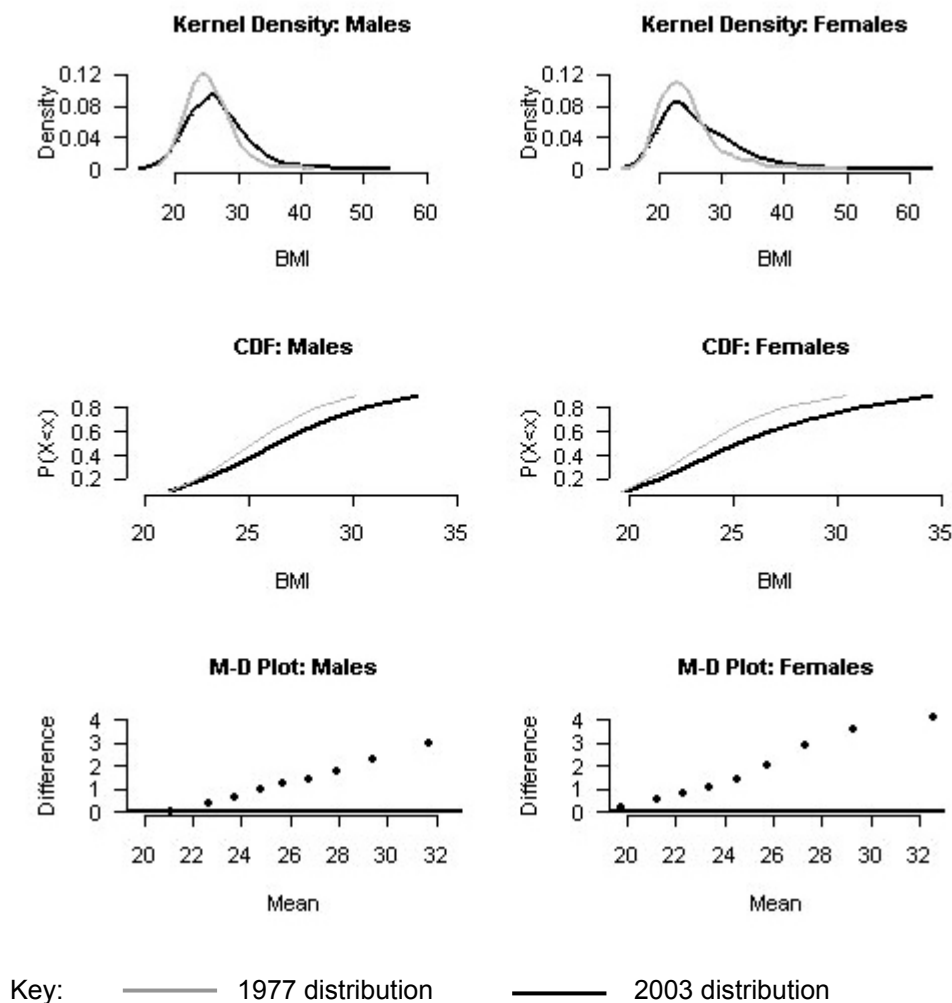
# Results – Total Population

## BMI distributions

### Changes in BMI distribution, 1977–2003

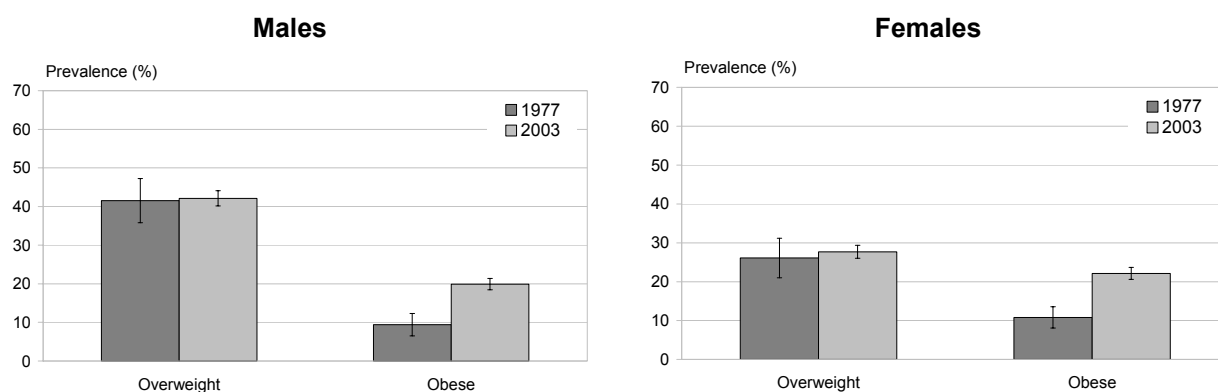
We first describe the changes in the BMI distribution and the prevalence of overweight and obesity over the whole 1977–2003 period (Figures 11 and 12, Table 3).<sup>3</sup> Gender-specific results are presented, but all age groups have been pooled to provide a population-level overview (ages 20–64 years for 1977 and 15–74 years for 2003).

**Figure 11:** Changes in BMI distribution, ages pooled, 1977–2003



<sup>3</sup> Figure 11 shows the epidemic at a glance – a visualisation not previously available, yet useful for setting and (with appropriate updates) evaluating the policy response to the epidemic.

**Figure 12:** Prevalence of overweight and obesity, ages pooled, 1977–2003



**Table 3:** Selected sample statistics, ages pooled, 1977–2003

	Males			Females		
	1977	2003	AAPC (%)*	1977	2003	AAPC (%)*
Mean BMI	25.5	26.9	0.20	24.5	26.4	0.28
Median BMI	25.1	26.3	0.18	23.8	25.2	0.23
Overweight (%)	41.5	42.1	0.05	26.1	27.7	0.23
Obese (%)	9.4	19.9	2.93	10.8	22.1	2.79

\* Average annual percentage change; assumes linearity.

These results confirm that an epidemic of obesity has occurred in New Zealand over the past quarter century. In fact, it is clear that the epidemic began even earlier than the 1970s, since by 1977 42 percent of adult males and 26 percent of adult females were already overweight, and 9 percent and 11 percent, respectively, were already obese (ie, 51 percent of males and 37 percent of females were already either overweight or obese).

The obesity epidemic has affected both genders equally. From 1977 to 2003 the prevalence of obesity increased from 11 to 22 percent among females, and from 9 to 20 percent among males (relative increases of 100 percent and 116 percent, respectively). This corresponds to an AAPC of around 3 percent for both genders, assuming log linearity (a constant rate of change over the 26-year period).

Changes in the prevalence of overweight over the study period have, by contrast, been minimal, with males showing only a 1.4 percent and females a somewhat larger 6.1 percent relative increase (corresponding to absolute increases of 0.6 and 1.6 percentage points, respectively). The prevalence of overweight among males has thus remained almost stable over the entire 26 years, at approximately 42 percent, while among females only a very slight increase has been seen – from approximately 26 to 28 percent.

This differential trend in the prevalence of obesity versus that of overweight indicates increasing skewness in the BMI distribution over time. A major proportion of the change has involved people who were already obese becoming even more obese, together with a proportion of people who were already overweight moving up into the obese category, and a similar proportion of people who were previously of normal weight becoming overweight.<sup>4</sup> Overall, the prevalence of obesity has slightly more than doubled, and that of normal weight has declined by about one-fifth, while that of overweight has remained virtually unchanged. Furthermore the average BMI of the obese subpopulation increased from 33.5 units in 1977 to 34.1 units in 2003 for males, and from 34.5 to 35.2 units, respectively, for females. At the same time, the prevalence of extreme obesity increased from 0.3 to 2.2 percent among males and from 1.2 to 3.0 percent among females (see ‘Trends in Extreme Obesity’ section for more detail).

The increasing skewness of the BMI distribution can be seen also by examining the change in mean and median BMI over the study period. Mean BMI increased by 1.4 units among males (from 25.5 at the beginning to 26.9 at the end of the observation period) and by a somewhat larger 1.9 units (from 24.5 to 26.4) among females. This is an AAPC in mean BMI of 0.2 percent for males and 0.3 percent for females, assuming log linearity. The change in median BMI was slightly smaller (1.2 units among males and 1.4 units among females, an AAPC in mean BMI of 0.2 percent in both genders). This lesser change in median than mean BMI reflects increasing skewness in the BMI distribution.

So the typical adult male of average stature weighed 77.5 kg in 1977 but 86.2 kg in 2003, equivalent to an average daily weight gain of approximately 0.9 g/day over the 26 years.<sup>5</sup> Similarly, the typical adult female of average stature weighed 65.0 kg in 1977 and 72.2 kg in 2003, which is equivalent to an average daily weight gain of 0.8 g/day over the same period. (More detail about trends in average stature over the study period is provided later – see ‘Trends in Stature’ section).

Examining the whole BMI distribution (Figure 11), the overall pattern (ie, across all ages and calendar years) is consistent with the mixed model, although the male pattern is close to a high-risk subgroup model. The kernel density plots show a fall in the peak density accompanied by thickening of the right-hand tail, indicating increasing skewness of the distribution with very little change in the lighter percentiles. This is borne out by the cumulative distributions for 1977 and 2003, which are superimposed at the lower end but diverge increasingly toward the upper end. Likewise, the m–d plots show data points near zero at lighter percentiles, but rising progressively away from zero at higher percentiles. These plots also show that the increase in skewness was greater for females, with BMI differences reaching over three units at the heaviest percentiles for females versus less than three units for males.

<sup>4</sup> Since this conclusion is based on serial cross-sectional data, it relies on the assumption that adults generally do not shift back and forth across BMI categories.

<sup>5</sup> This estimate is approximate, as it is based on serial cross-sectional surveys rather than a cohort study. The increase in weight gain (in g/day) is based on an assumed linear increase.

In summary, the overall pattern has been one of increasing skewness in the population BMI distribution (ie, a mixed or possibly a high-risk subgroup model), with the prevalence of obesity more than doubling (from 9 to 20 percent among males and from 11 to 22 percent among females); while the prevalence of overweight has remained essentially stable (42 percent for males and 26 percent for females), and mean (median) BMI has increased by 1.4 (1.2) units in males and 1.9 (1.4) units in females. That is, the prevalence of obesity has increased at an average rate of approximately 3 percent per year<sup>6</sup> (both genders) while the prevalence of overweight has remained stable and mean (median) BMI has shifted at a rate of approximately 0.2 (0.3) percent per year.

It is also worth noting the different pattern of the epidemic in males compared to females: across the entire study period, males are more likely to be overweight while females are more likely to be obese. With the prevalence of overweight remaining stable in both genders yet that of obesity doubling, the ratio of overweight to obese individuals has declined sharply over the study period, from 4.4 to 2.1 among males and from 2.4 to 1.2 among females. That is, there are now only two overweight males for every obese male, while the number of obese females already almost equals the number of overweight females. Again, this falling ratio is an inevitable consequence of the increasing skewness in the BMI distribution.

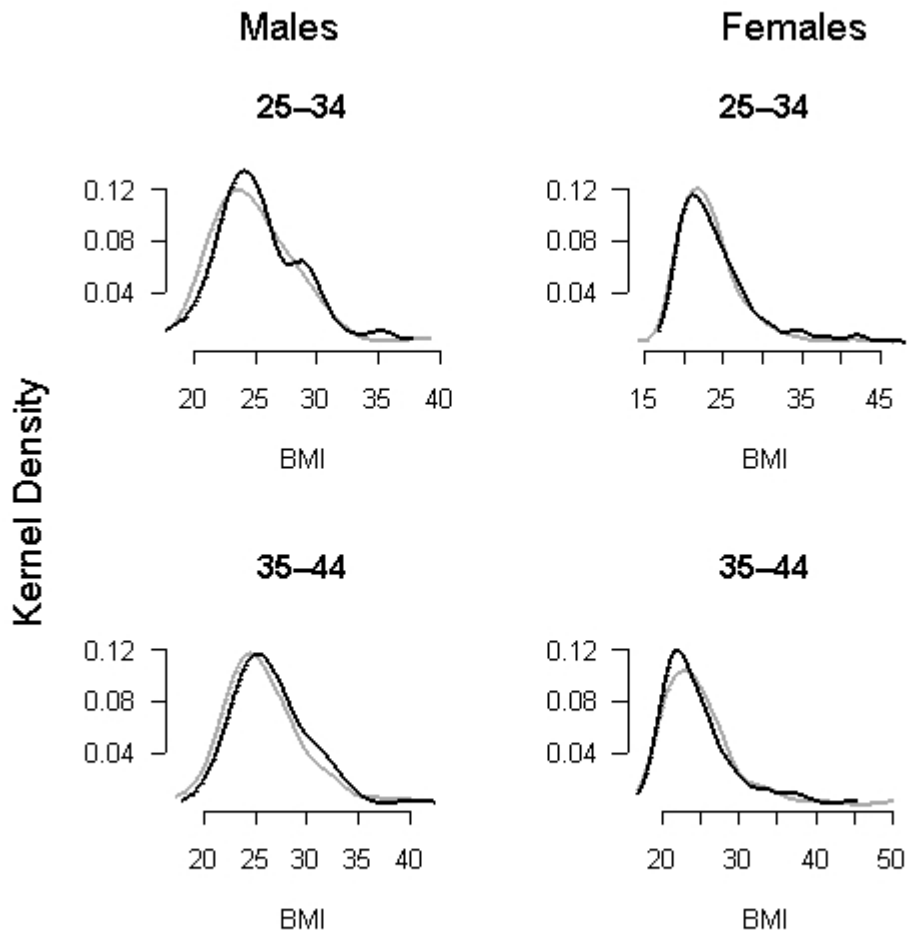
The overall pattern from 1977 to 2003 disguises significant variation between age groups and periods, variations which are explored in detail in the next three sections of this report.

<sup>6</sup> This refers to a relative increase of 3 percent, not three percentage points.

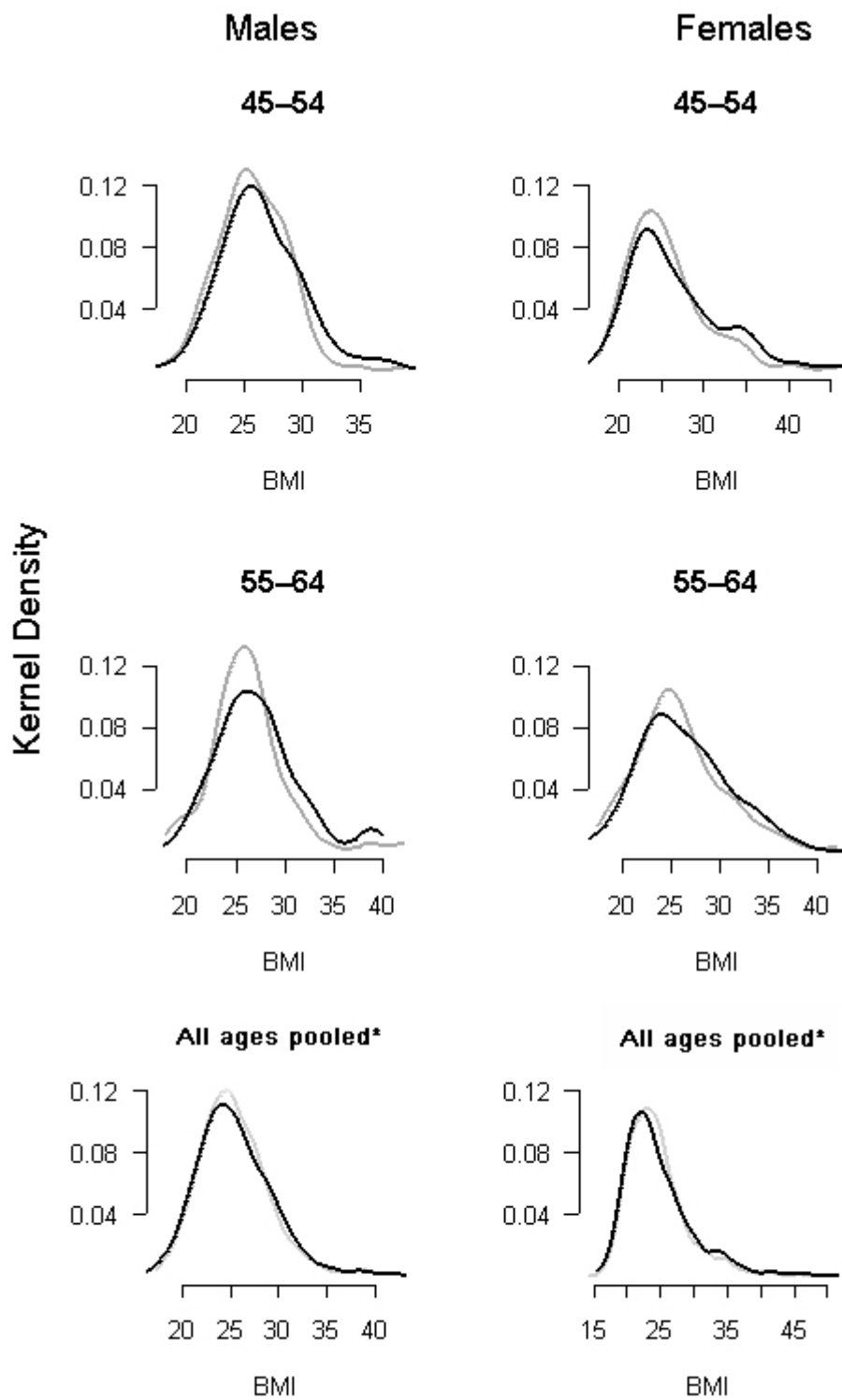
### Changes in BMI distribution, 1977–1989

We now look at changes in the distribution of BMI from 1977 to 1989 (first period), by age group and gender (Figures 13–16, Tables 4 and 5). Because of age restrictions in the 1977 National Diet Survey, our analysis is limited to ages 25–64 years.

**Figure 13:** Kernel densities of BMI, 1977–1989



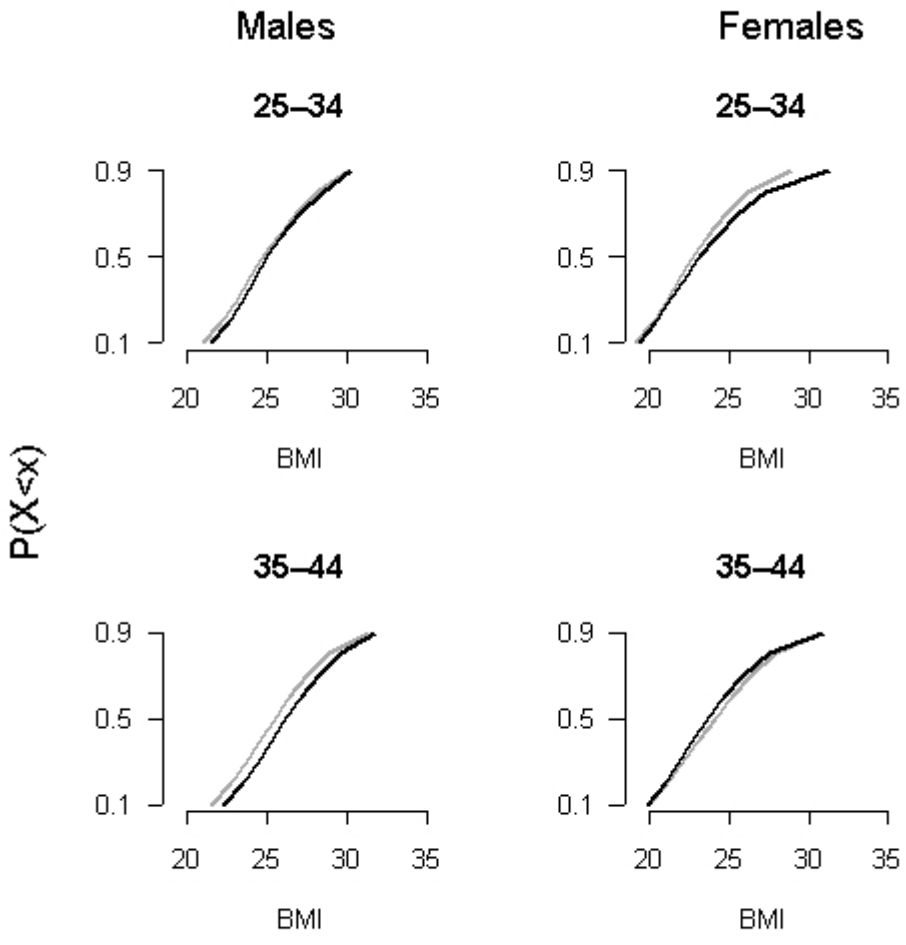
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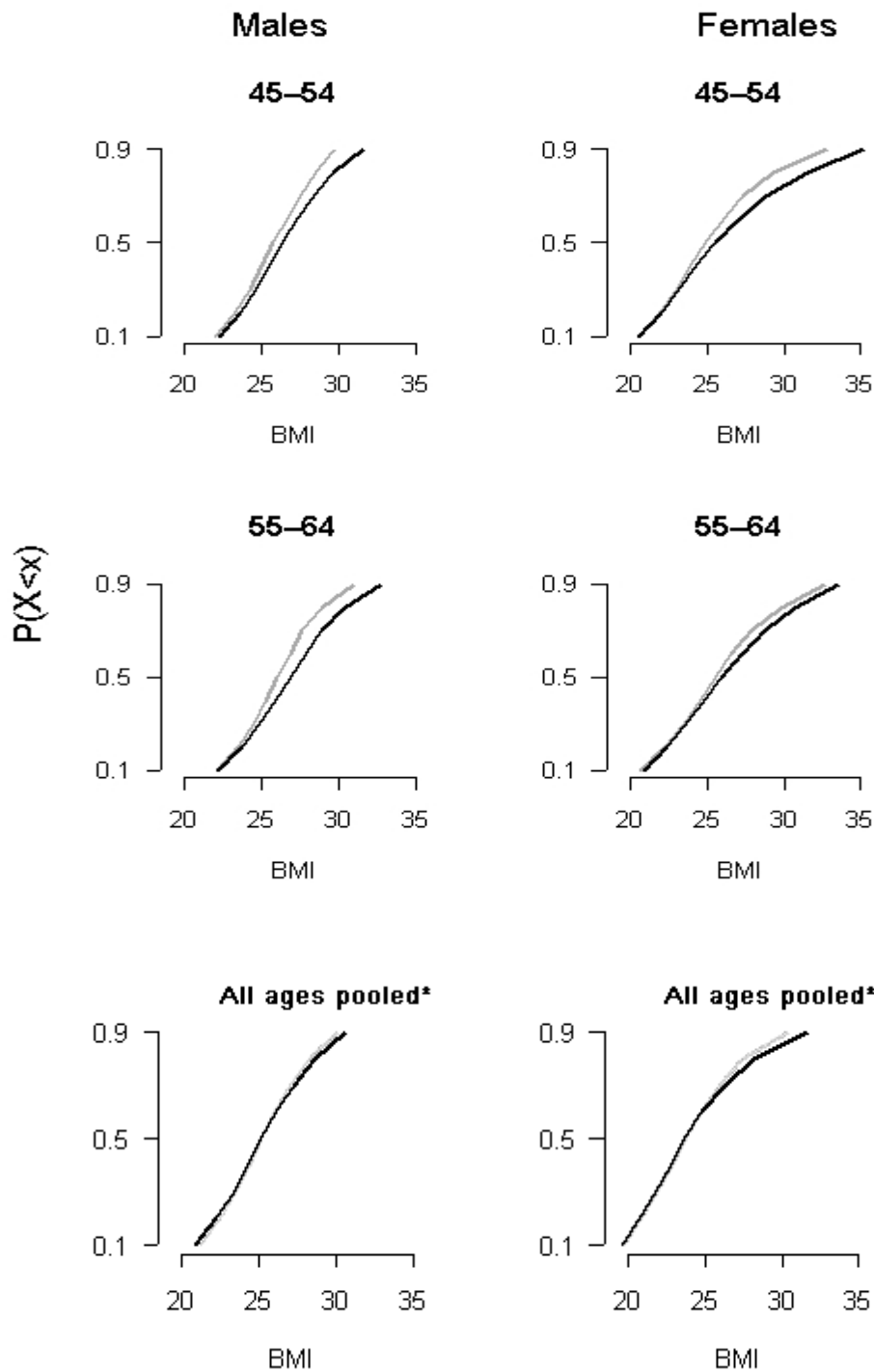
Key: — 1977 distribution — 1989 distribution

\* 20-64 years for 1977 and 15-74 years for 1989.

**Figure 14:** Cumulative distribution functions, 1977–1989



Key: — 1977 distribution      — 1989 distribution

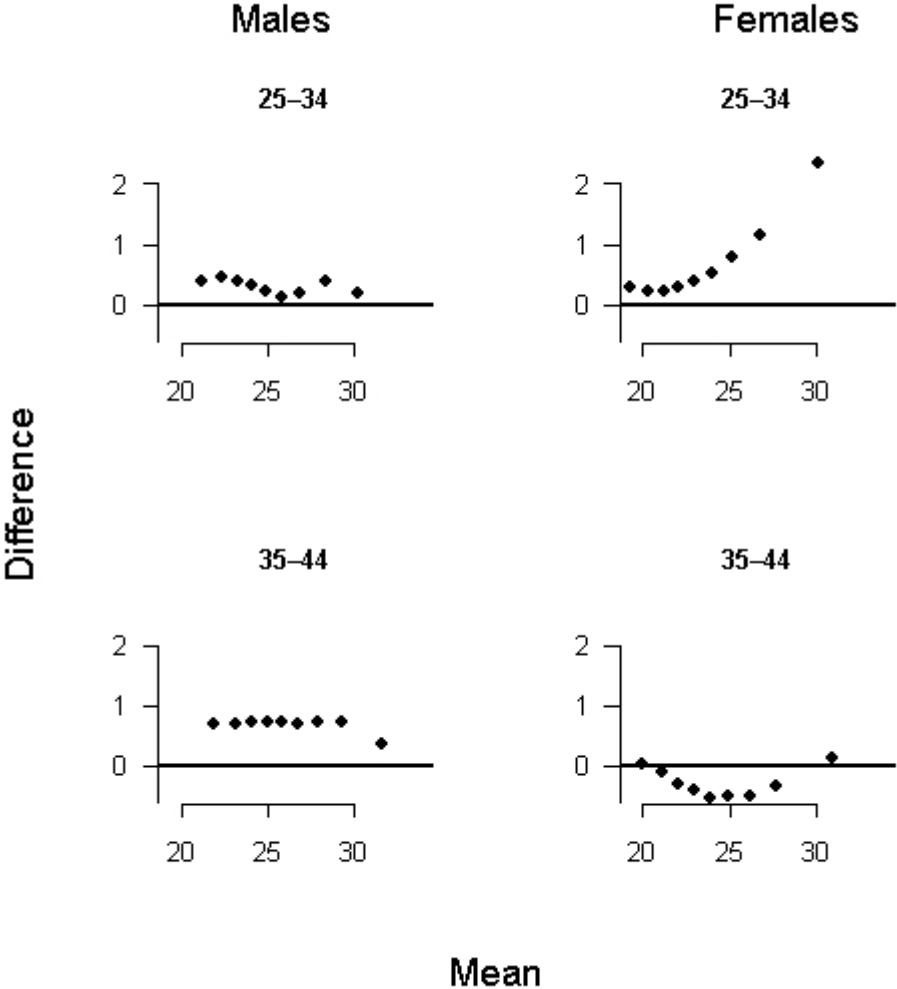


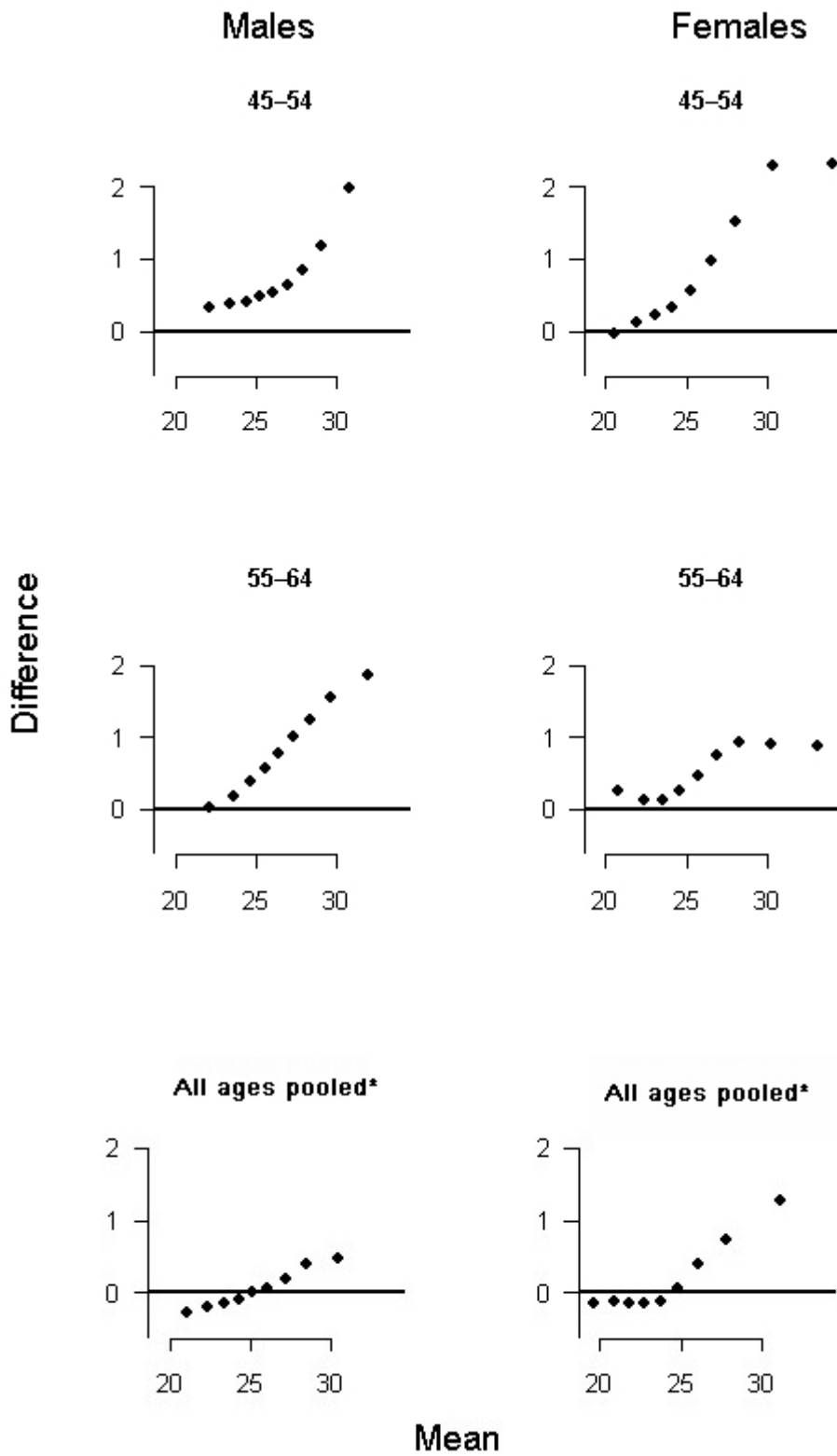
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\* 20–64 years for 1977 and 15–74 years for 1989.



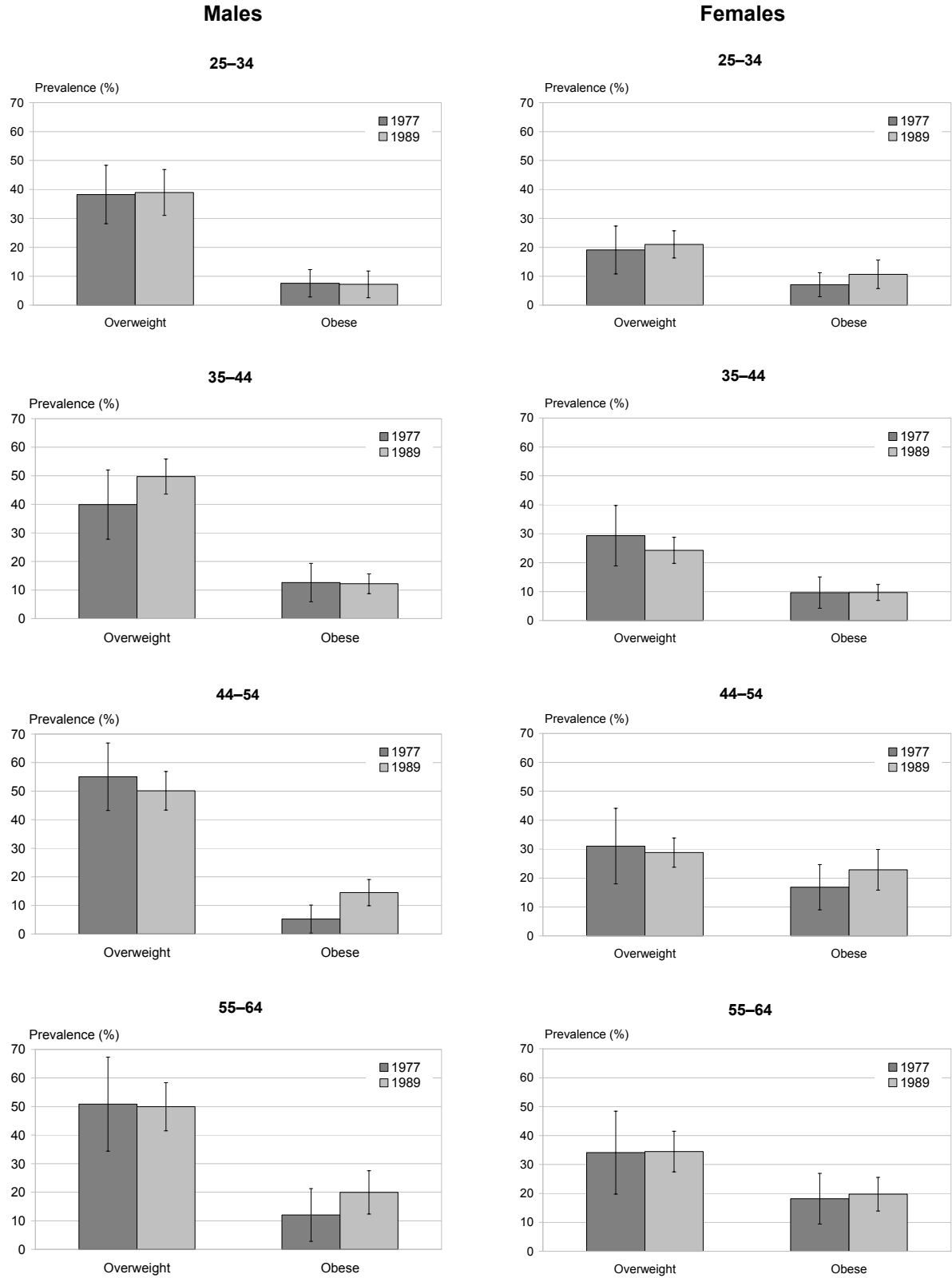
**Figure 15:** Tukey mean–difference plots, 1977–1989

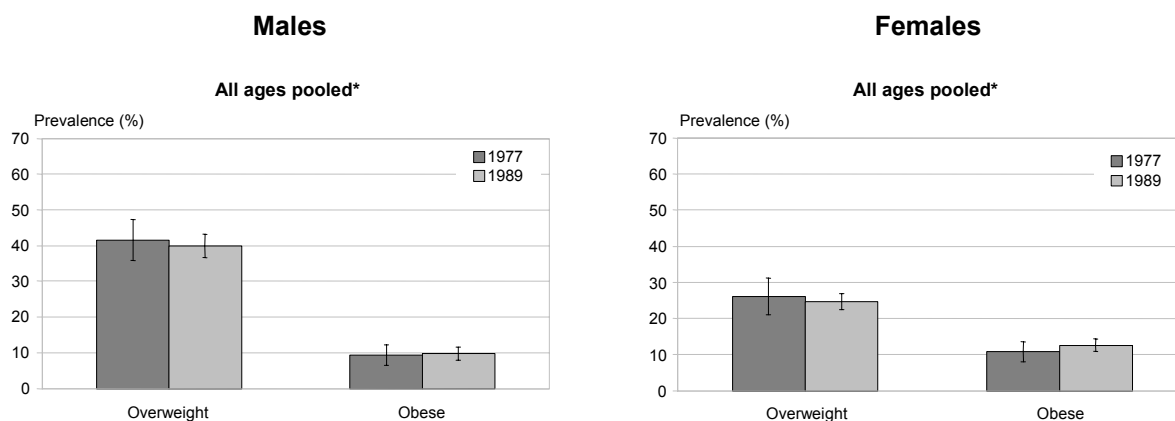




\* 20-64 years for 1977 and 15-74 years for 1989.

**Figure 16:** Prevalence of overweight and obesity, 1977–1989





\* 20–64 years for 1977 and 15–74 years for 1989.

**Table 4:** Selected sample statistics, by 10-year age group (males), 1977–1989

Statistic	Year	25–34	35–44	45–54	55–64	All ages**
Mean BMI	1977	25.1	26.0	25.8	26.3	25.5
	1989	25.4	26.6	26.8	27.2	25.6
	AAPC*	0.12	0.20	0.31	0.30	0.02
Median BMI	1977	24.6	25.3	25.6	25.9	25.1
	1989	24.8	26.1	26.2	27.0	25.1
	AAPC*	0.05	0.28	0.20	0.34	0.00
Overweight (%)	1977	38.2	39.9	55.1	50.9	41.5
	1989	39.0	49.7	50.1	49.9	40.0
	AAPC*	0.16	1.85	-0.78	-0.15	-0.32
Obese (%)	1977	7.6	12.6	5.2	12.0	9.4
	1989	7.2	12.2	14.5	20.0	9.8
	AAPC*	-0.41	-0.28	8.85	4.30	0.33

\* Average annual percentage change; assumes linearity.

\*\* For the all ages pooled analysis, 1977 statistics include ages 20–64 years and 1989 statistics include ages 15–74 years.

**Table 5:** Selected sample statistics, by 10-year age group (females), 1977–1989

Statistic	Year	25–34	35–44	45–54	55–64	All ages**
Mean BMI	1977	23.6	24.8	25.7	25.8	24.5
	1989	24.3	24.6	26.8	26.6	24.8
	AAPC*	0.27	-0.06	0.33	0.24	0.08
Median BMI	1977	22.7	24.0	24.7	25.2	23.8
	1989	22.9	23.5	25.3	25.7	23.6
	AAPC*	0.09	-0.19	0.23	0.17	-0.08
Overweight (%)	1977	19.1	29.3	31.1	34.1	26.1
	1989	21.0	24.3	28.8	34.5	24.6
	AAPC*	0.81	-1.57	-0.62	0.09	-0.49
Obese (%)	1977	7.1	9.6	16.9	18.2	10.8
	1989	10.7	9.7	22.8	19.7	12.5
	AAPC*	3.47	0.03	2.57	0.69	1.24

\* Average annual percentage change; assumes linearity.

\*\* For the all ages pooled analysis, 1977 statistics include ages 20–64 years and 1989 statistics include ages 15–74 years.

Overall, the epidemic grew relatively slowly from 1977 to 1989. The pattern was different for males and females, and also varied across age groups.

Across all adult ages (25–64 years), the prevalence of obesity among males remained almost static, increasing from 9.4 percent in 1977 to 9.8 percent in 1989, an AAPC of 0.3 percent, assuming log linearity. However, this was because increases in obesity prevalence among middle-aged males were largely offset by slight decreases among young adult males. Females showed an increase in obesity prevalence across all age groups except the 35–44 years age group (which remained stable), with the pooled increase across all ages being from 10.8 to 12.5 percent, an AAPC of 1.2 percent, assuming log linearity.

Both males and females showed very little change in overweight prevalence at any age (except for males age 35–44 years who showed an increase, and females aged 45–54 years who showed a decrease).

Mean BMI for males increased by approximately 0.5 BMI units among young adults and by approximately 1 BMI unit among middle-aged adults. The pattern was similar (though smaller in absolute differences) for median BMI. Females showed a more consistent pattern of increasing mean and (to a lesser extent) median BMI across all age groups, except for the 35–44 years age group, which showed little change.

Examining the full BMI distributions (eg, using the m–d plots), young adult males showed very little change at all (except for the 35–44 years age group who showed a uniform increase). Middle-aged males showed a typical mixed pattern, with increasing skewness at the higher percentiles (reaching up to 1.5 BMI units) but little change at the lower percentiles. Except for the 35–44 years age group, females also showed increasing skewness at higher percentiles (ie, a mixed pattern) at all ages, reaching up to 2 BMI units (approximately) in the 45–54 years age

group. The ‘anomalous’ behaviour of 35–44-year-old females, and to a lesser extent males, has no obvious explanation but may reflect chance, selection bias or possibly a cohort effect.

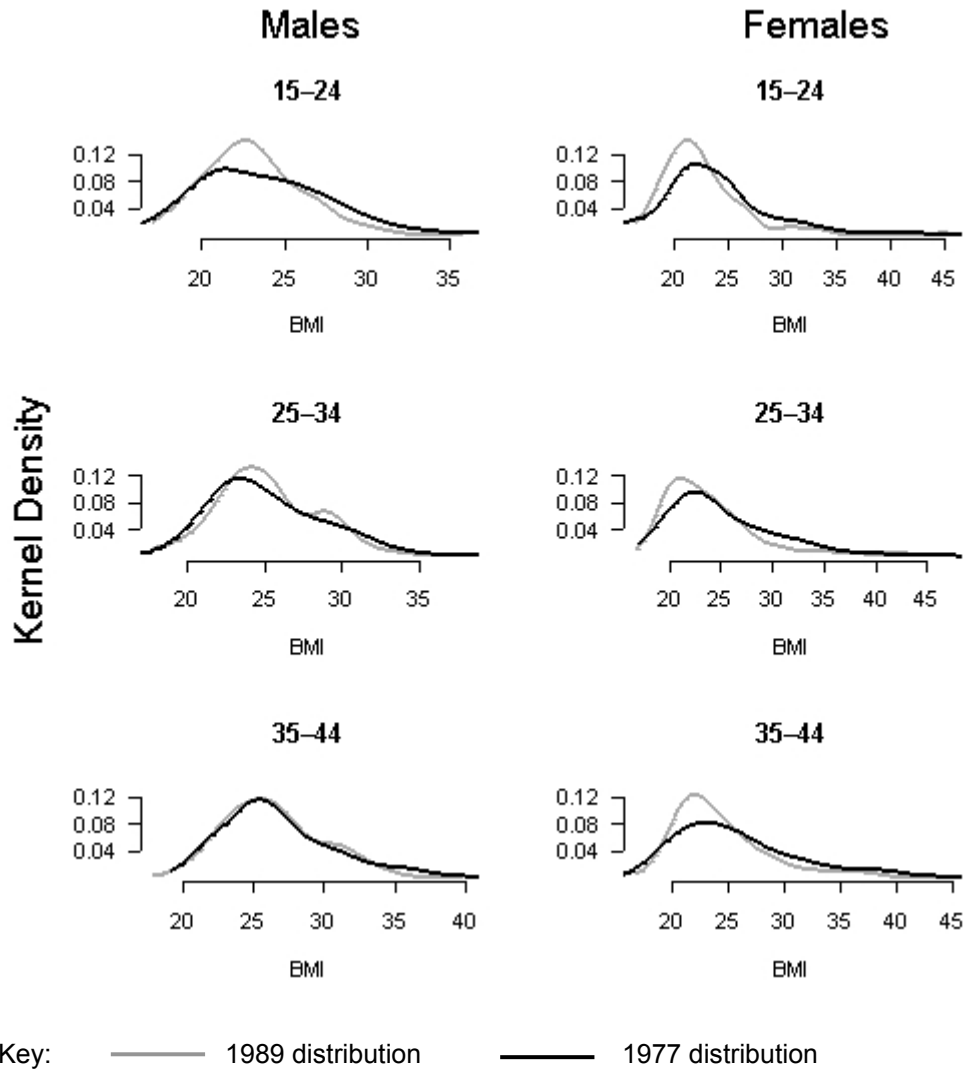
In summary, from 1977 to 1989 females of all ages within the 25–64 years age range, except for the 35–44 years age group, demonstrated rightward BMI shifts with increasing skewness, leading to small but significant increases in mean and median BMI, with no change in the prevalence of overweight and modest increases in the prevalence of obesity. By contrast, the epidemic had not yet spread to include young adult males, although middle-aged males were already affected – indeed, almost as severely as middle-aged females.

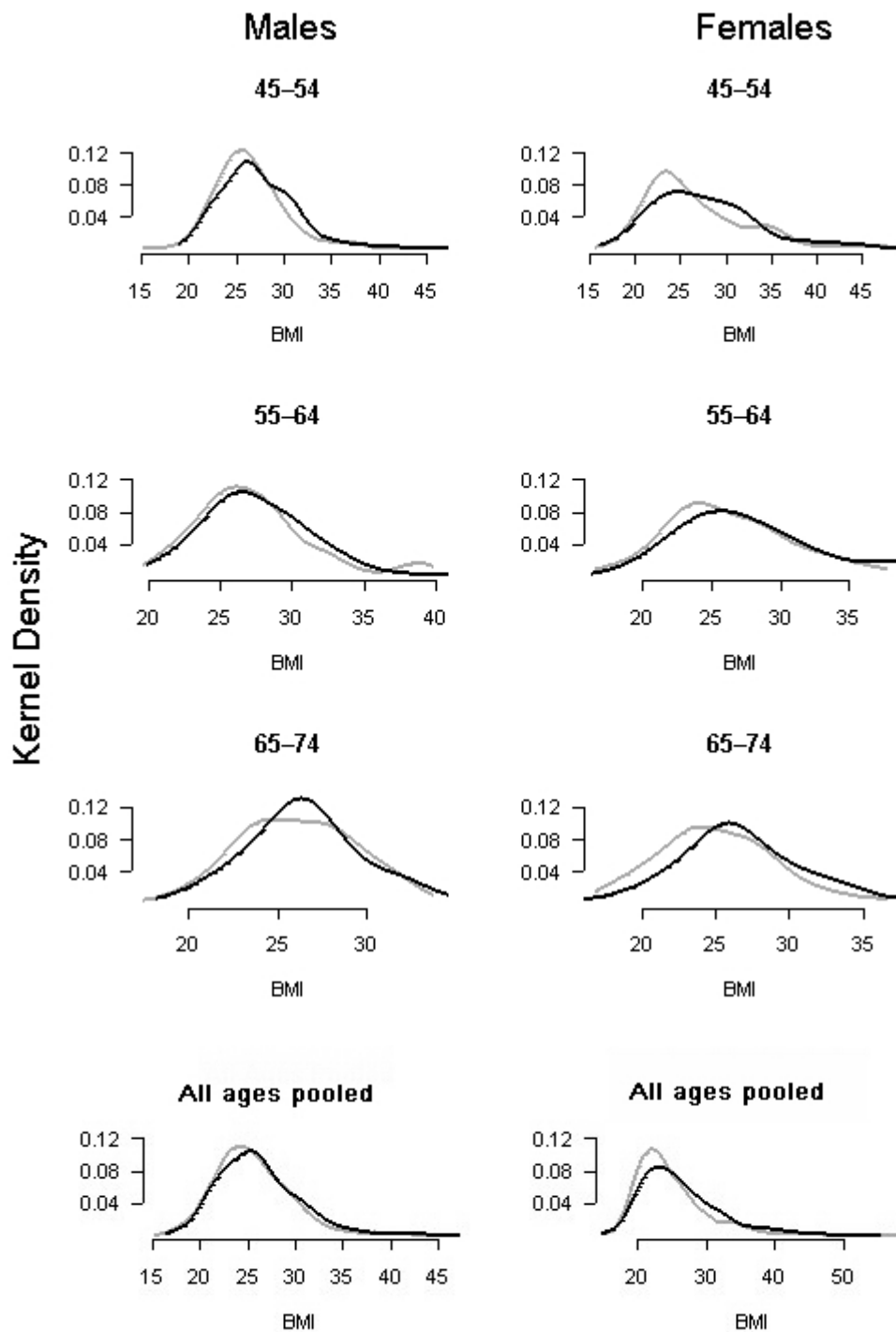
The epidemic, while it probably commenced well before the 1970s, was still slow growing even in the 1980s, and was still predominantly an epidemic of the middle-aged. Females showed a greater skewness in their BMI distribution – affecting a broader age range – than males, suggesting that the epidemic was already more advanced among females, and may have begun first in middle-aged females before spreading to older and younger (female) age groups and to middle-aged males.

## Changes in BMI distribution, 1989–1997

Changes in the distribution of BMI from 1989 to 1997 (second period) are examined in the following section (Figures 17–20, Tables 6 and 7). Ages 15–74 years are included (75+ were not included because there were insufficient numbers of survey participants in this age group).

**Figure 17:** Kernel densities of BMI, 1989–1997

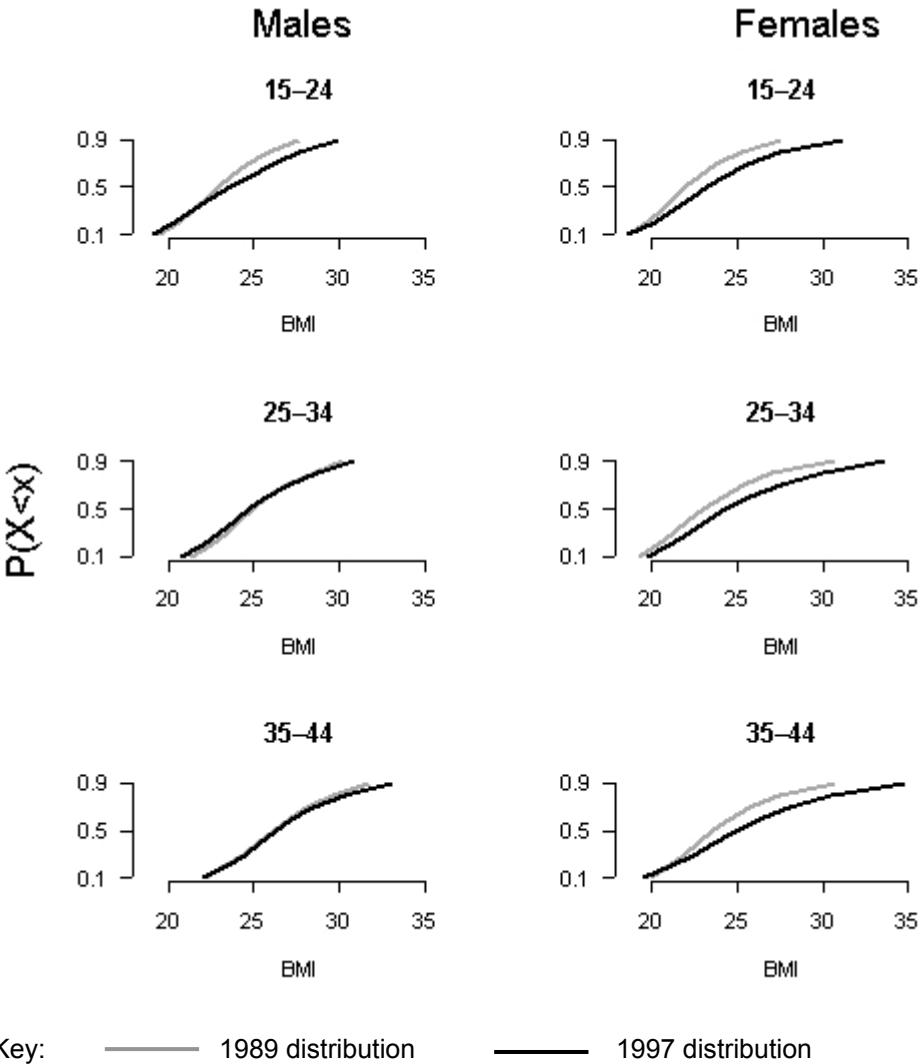


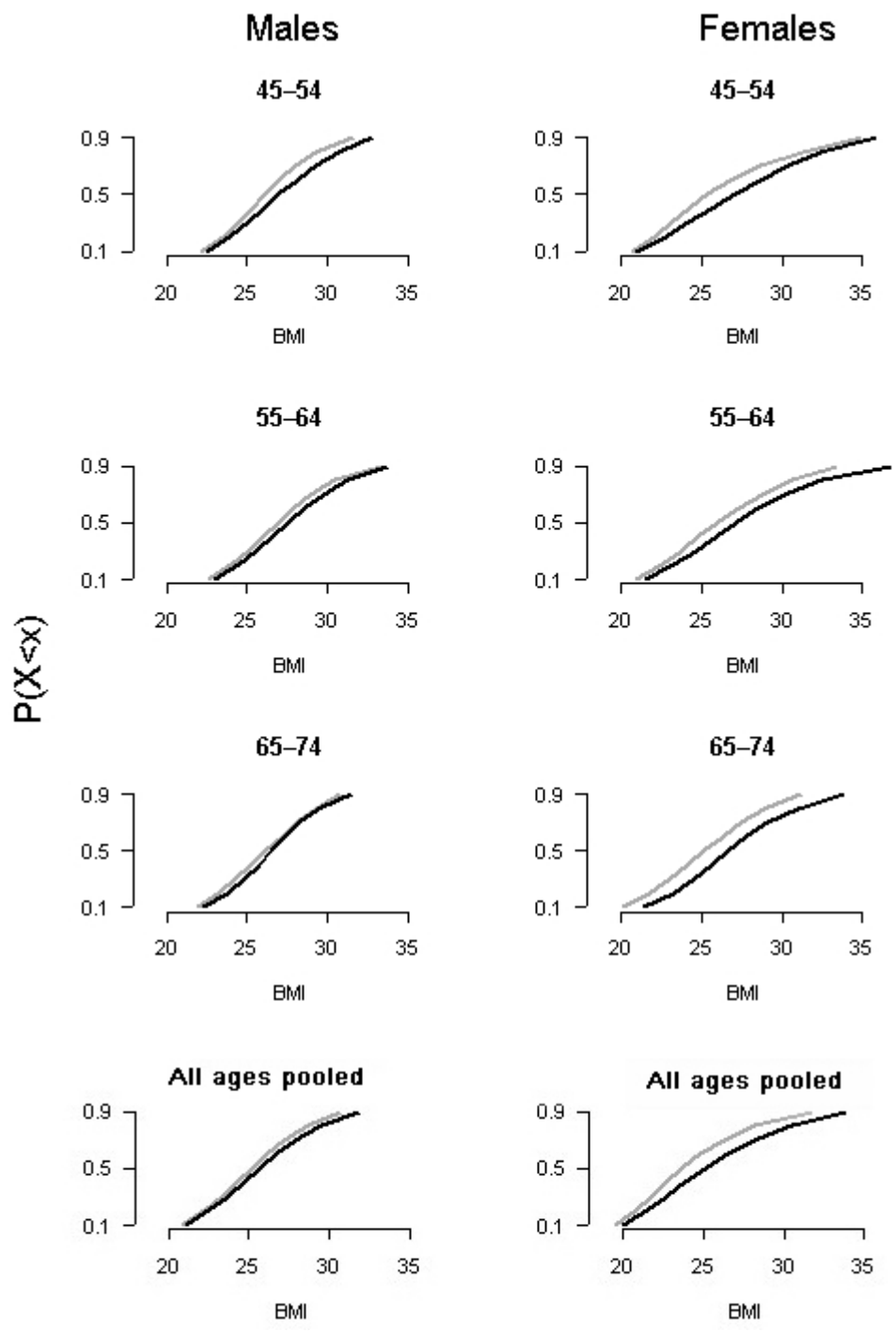


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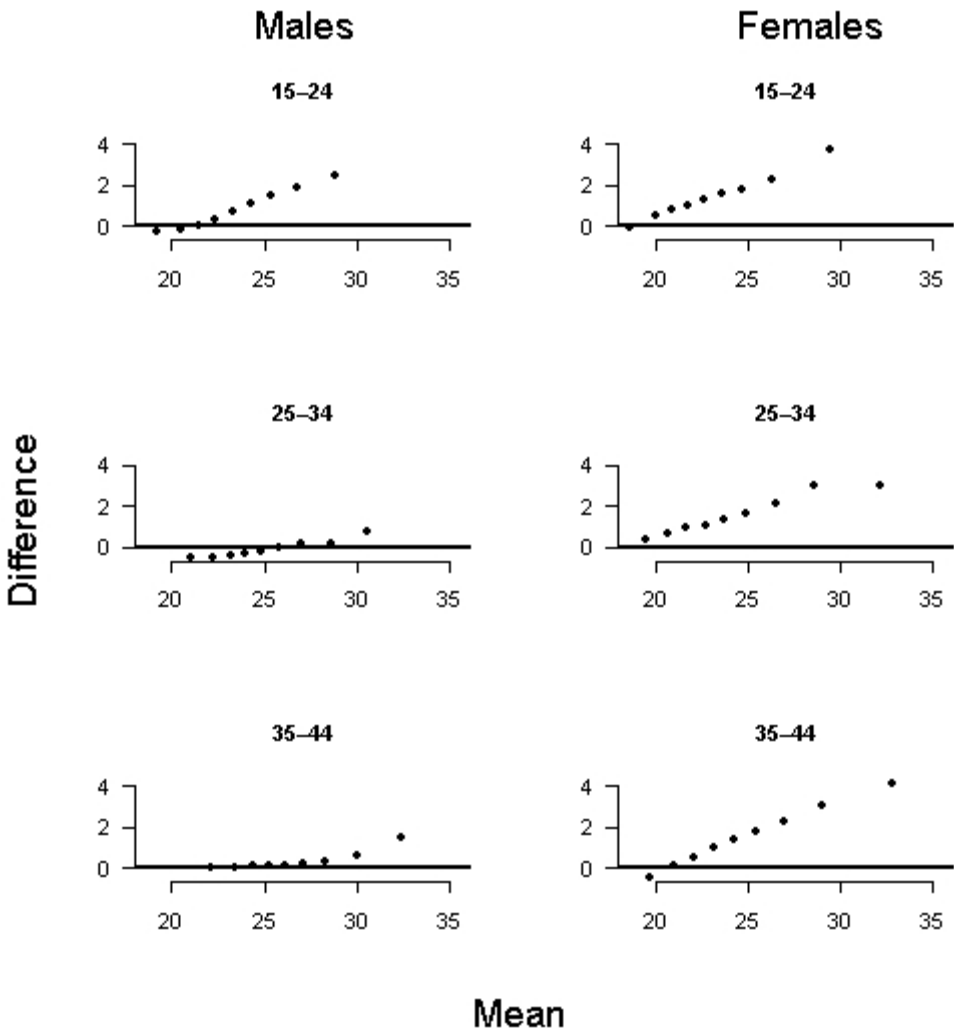
**Figure 18:** Cumulative distribution functions, 1989–1997

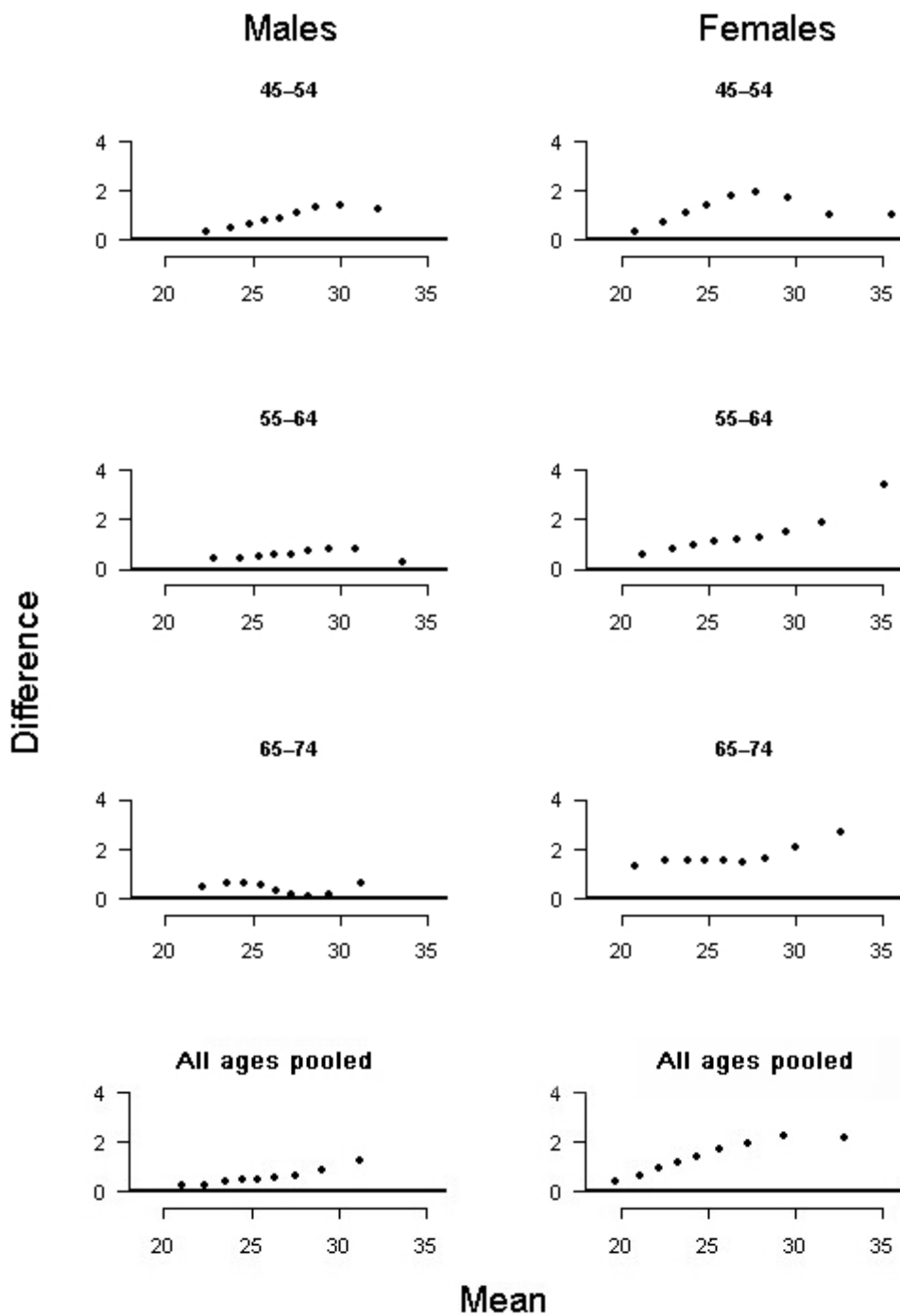




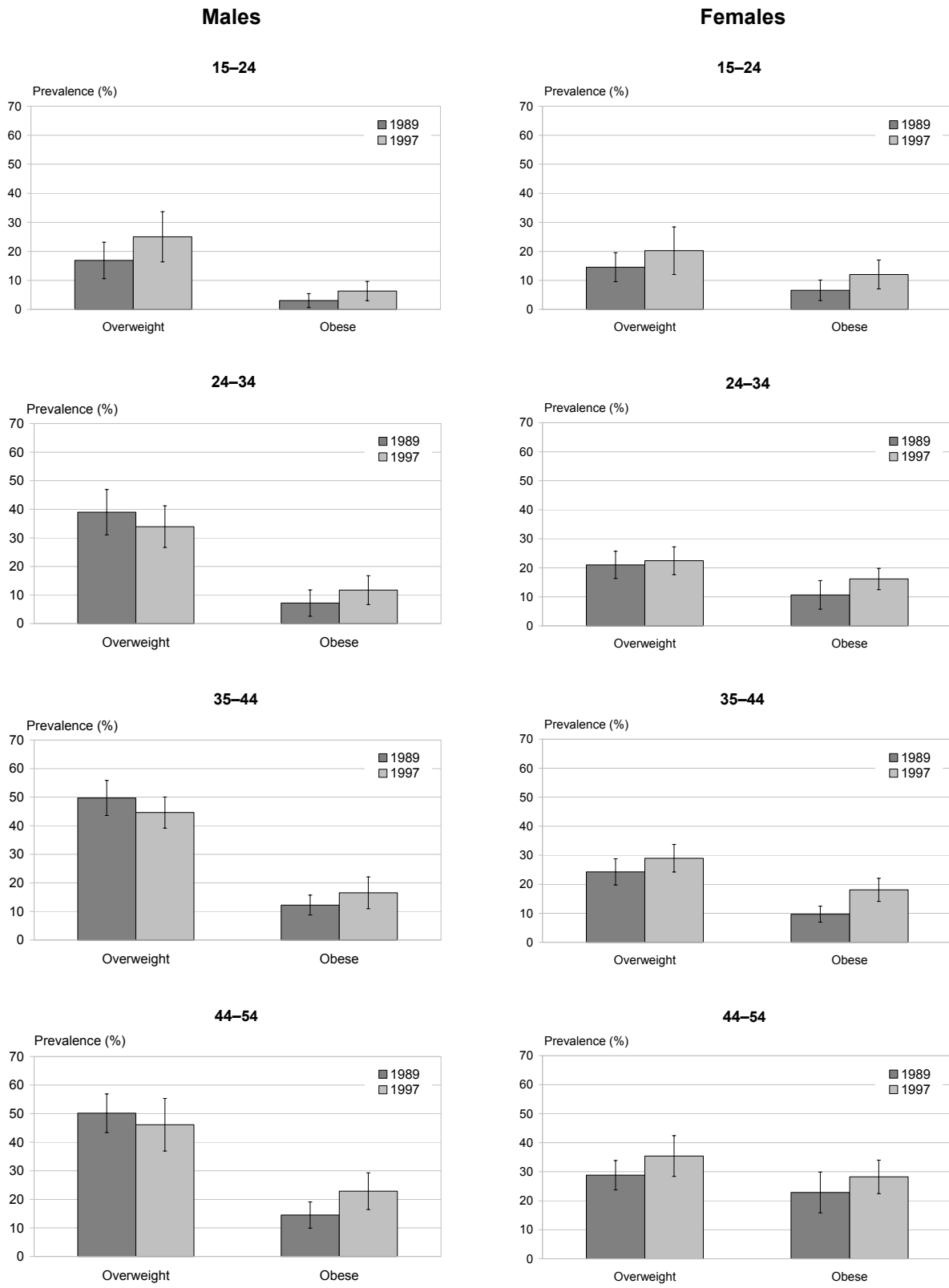
Key: — 1989 distribution      — 1997 distribution

**Figure 19:** Tukey mean difference plots, 1989–1997



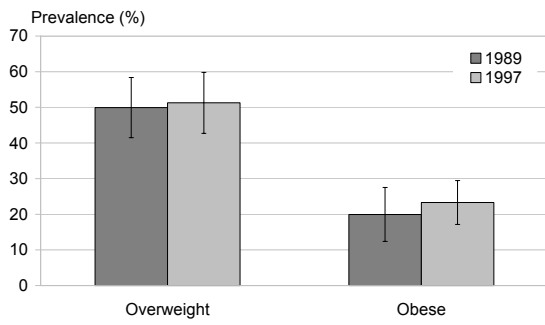


**Figure 20:** Prevalence of overweight and obesity, 1989–1997



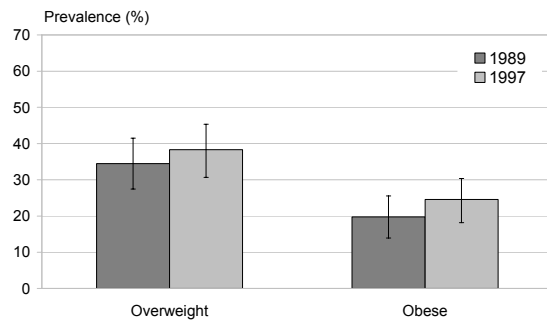
### Males

55-64

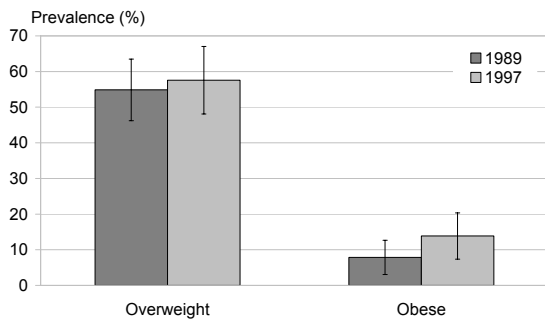


### Females

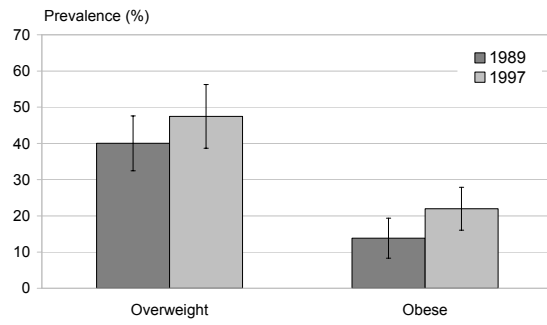
55-64



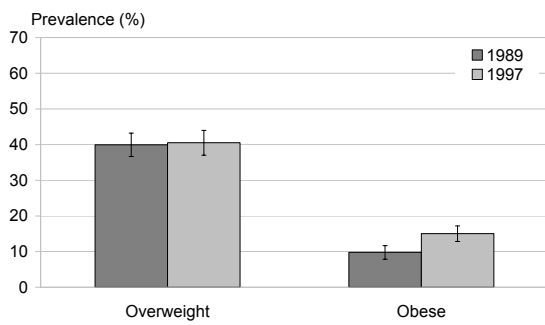
65-74



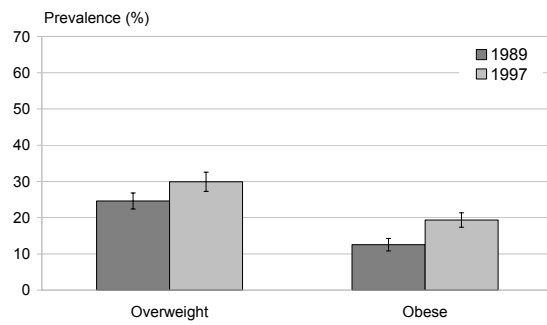
65-74



All ages pooled



All ages pooled



**Table 6:** Selected sample statistics, by 10-year age group (males), 1989–1997

Statistic	Year	15–24	25–34	35–44	45–54	55–64	65–74	All ages*
Mean BMI	1989	23.0	25.4	26.6	26.8	27.2	26.4	25.6
	1997	24.2	25.5	26.9	27.5	27.8	26.6	26.2
	AAPC*	0.63	0.02	0.12	0.31	0.27	0.09	0.31
Median BMI	1989	22.6	24.8	26.1	26.2	27.0	26.2	25.1
	1997	23.4	24.9	26.0	26.5	27.0	26.3	25.7
	AAPC*	0.44	0.04	-0.04	0.14	0.03	0.08	0.28
Overweight (%)	1989	16.9	39.0	49.7	50.1	49.9	54.9	40.0
	1997	25.0	33.9	44.6	46.1	51.3	57.6	40.5
	AAPC*	5.05	-1.72	-1.35	-1.04	0.32	0.61	0.17
Obese (%)	1989	3.0	7.2	12.2	14.5	20.0	7.9	9.8
	1997	6.3	11.7	16.5	22.9	23.3	13.9	15.0
	AAPC*	9.56	6.27	3.85	5.86	1.96	7.34	5.52

\* Average annual percentage change; assumes linearity.

**Table 7:** Selected sample statistics, by 10-year age group (females), 1989–1997

Statistic	Year	15–24	25–34	35–44	45–54	55–64	65–74	All ages*
Mean BMI	1989	23.0	24.3	24.6	26.8	26.6	25.6	24.8
	1997	24.1	25.3	26.1	27.9	27.8	27.2	26.2
	AAPC*	0.62	0.48	0.72	0.55	0.59	0.76	0.68
Median BMI	1989	21.9	22.9	23.5	25.3	25.7	25.5	23.6
	1997	22.8	23.8	24.9	27.1	26.7	26.3	25.0
	AAPC*	0.46	0.47	0.71	0.86	0.49	0.4	0.75
Overweight (%)	1989	14.5	21.0	24.3	28.8	34.5	40.0	24.6
	1997	20.2	22.4	29.0	35.4	38.3	47.5	29.9
	AAPC*	4.22	0.83	2.24	2.61	1.33	2.16	2.47
Obese (%)	1989	6.6	10.7	9.7	22.8	19.7	13.8	12.5
	1997	12.0	16.2	18.1	28.2	24.6	22.0	19.4
	AAPC*	7.82	5.32	8.13	2.68	2.78	5.95	5.58

\* Average annual percentage change; assumes linearity.

The epidemic accelerated sharply during the second period (1989–1997). For both genders, the prevalence of obesity increased sharply and fairly consistently across all ages. Pooling ages, the prevalence of obesity increased from 9.8 percent in 1989 to 15.0 percent in 1997 among males (an AAPC of 5.5 percent), and from 12.5 to 19.4 percent among females (an AAPC of 5.6 percent). However, unlike males (who showed stable overweight prevalence at 40 percent), females also showed significant increases in the prevalence of overweight (from 24.6 to 29.9 percent, an AAPC of 2.5 percent).

Among males, significant increases in mean BMI were only seen among youth and the middle-aged (half a BMI unit or more), but among females such increases occurred at all ages (typically 1 BMI unit or more). The same pattern was seen in median BMI for females, but changes in median BMI were similar for males at all ages, except youth.

Examination of the full BMI distributions extends these findings. Shifts in the distributions were minor for young adult males (although male youth showed a marked increase in skewness at heavier percentiles). Shifts were greater for middle-aged males, especially the 45–54 age group, although interestingly the pattern in this age–gender group is more one of a uniform upward shift (averaging about 1 BMI unit) of the whole subpopulation (a universal model) than one of increasing skewness. Older males showed little evidence of shift in their BMI distribution at all.

By contrast, females show the typical pattern of increasing skewness at heavier percentiles with little change at lighter percentiles, in all young adult and middle-aged groups. The pattern in 45–54-year-olds is anomalous, suggesting that the similar pattern seen in 35–44-year-olds in the first period (1977–1989) may indeed reflect a cohort effect. Older females, unlike older males, do show some distributional shifting, but this is uniform across all percentiles (ie, more a universal than a high-risk subgroup or mixed pattern in this older age group).

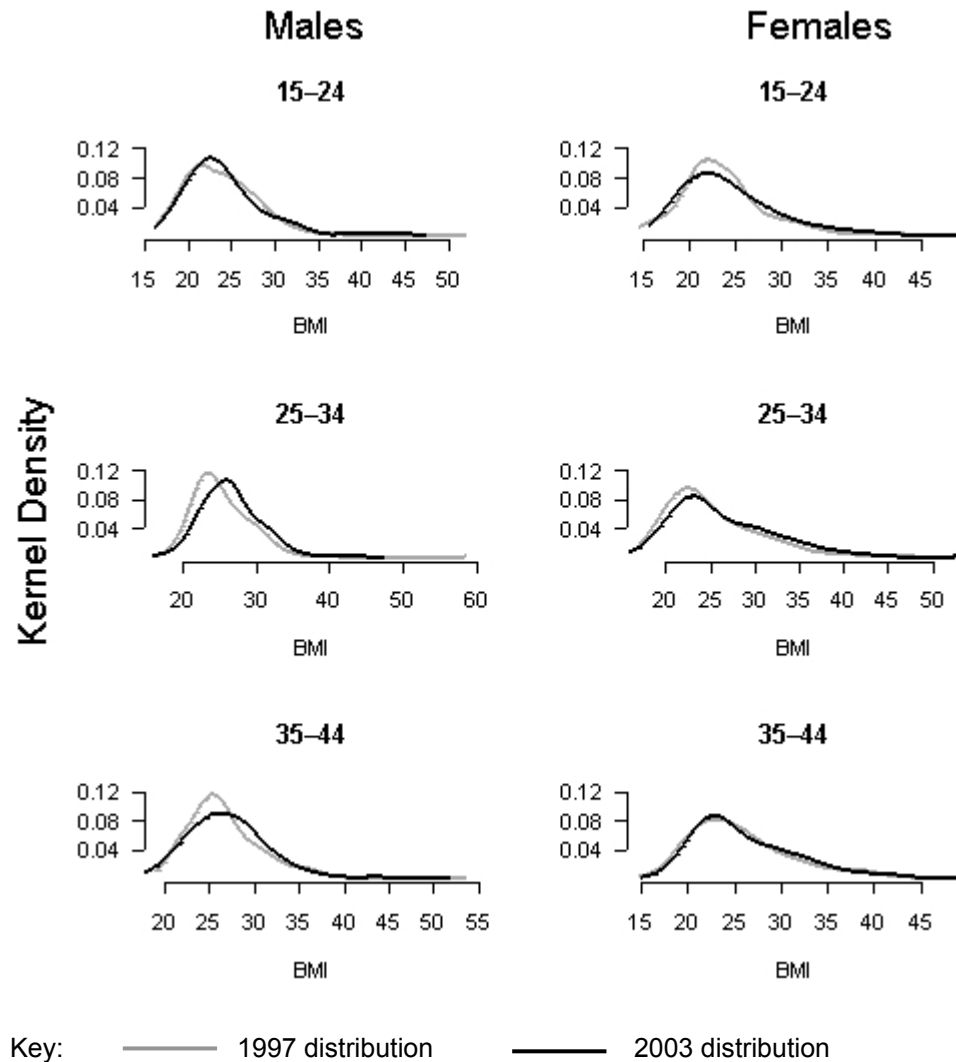
In summary, the shift in population BMI distribution from 1989 to 1997 was considerable. Almost all age groups of both genders were affected, older males being the major exception. The pattern of shifting was predominantly one of increasing skewness (ie, a mixed if not a high-risk subgroup model). The result was a steep increase in the prevalence of obesity (at an average growth rate of over 5 percent per year), with little change in the prevalence of overweight, especially among males. Mean and (to a lesser extent) median BMI increased significantly, but relatively slowly compared with the 90th percentile of the BMI distribution, which increased dramatically as obese people became even heavier on average, leading to a rapid increase in the prevalence of extreme obesity (see later for a detailed account of the evolution of extreme obesity).

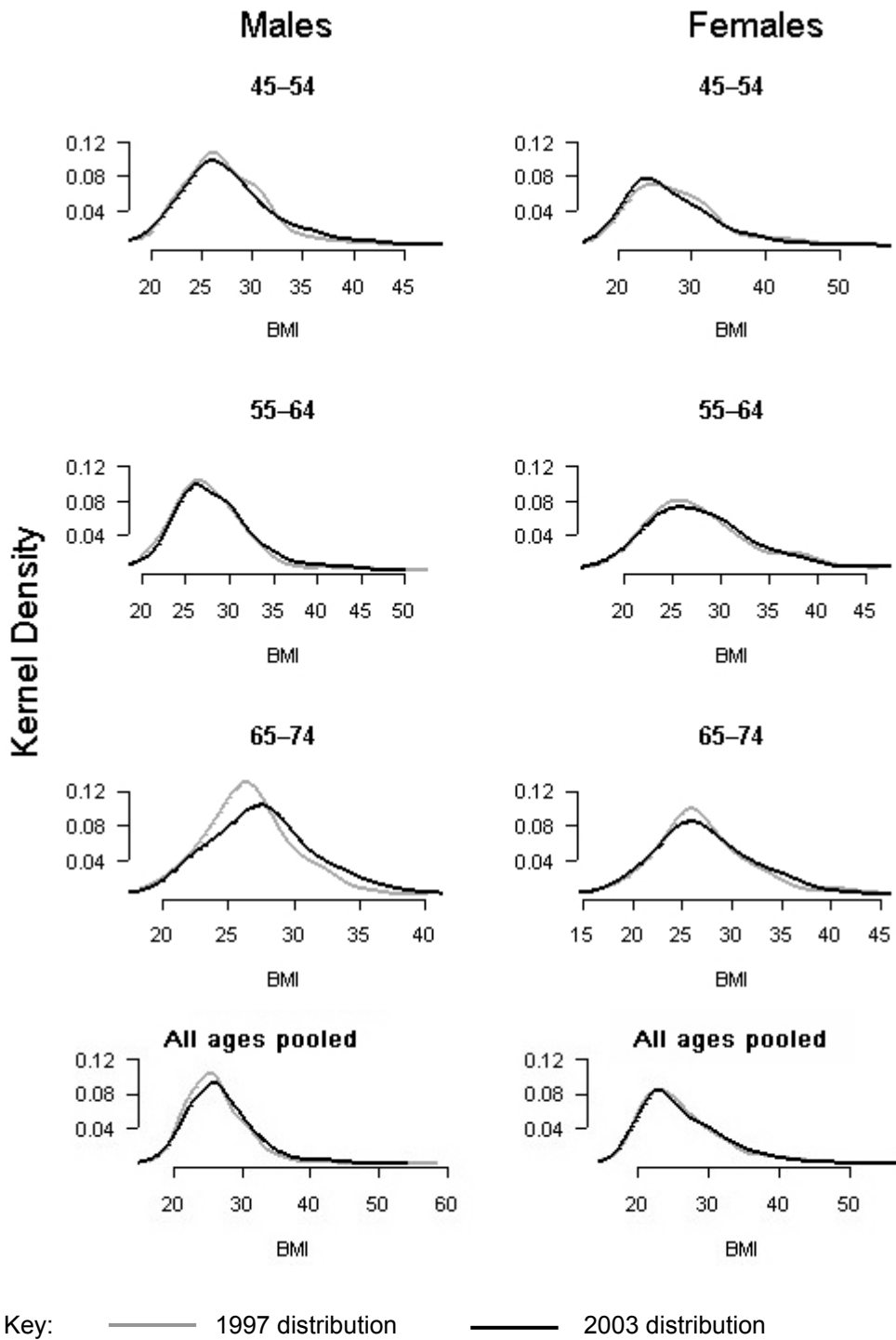


## Changes in BMI distribution, 1997–2003

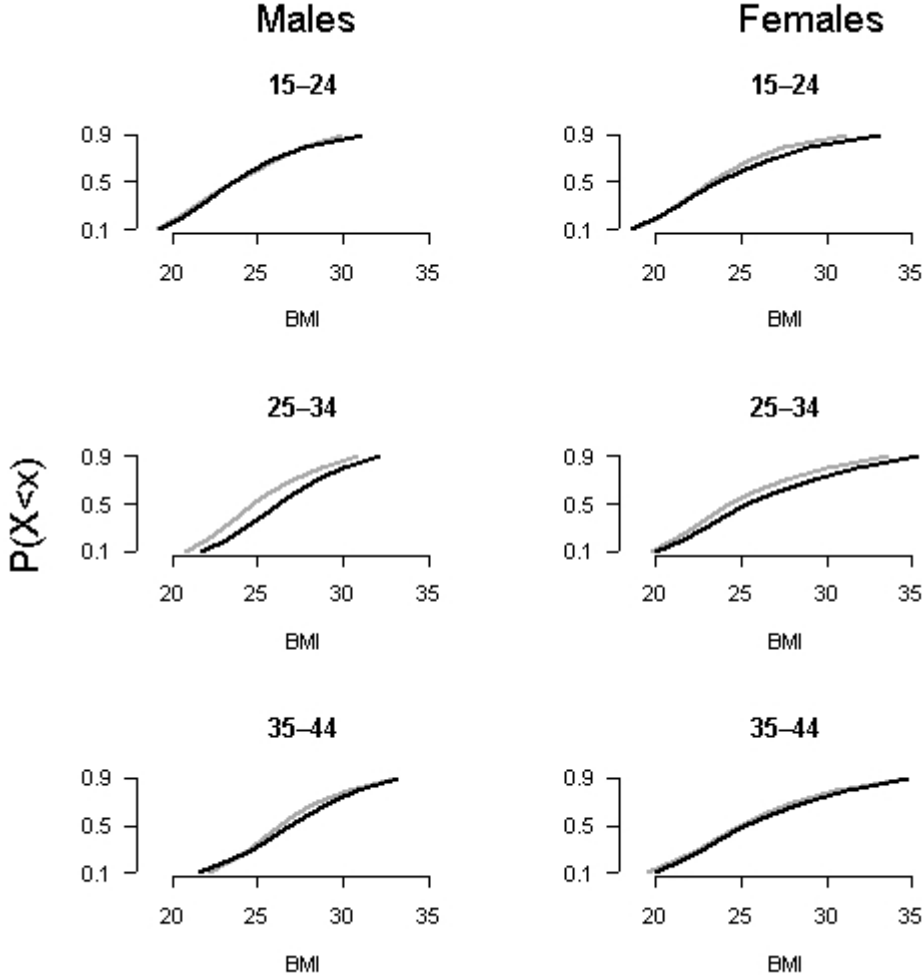
Changes in the distribution of BMI from 1997 to 2003 (third period) are examined in the following section for ages 15–74 years (Figures 21–24, Tables 8 and 9).

**Figure 21:** Kernel densities of BMI, 1997–2003

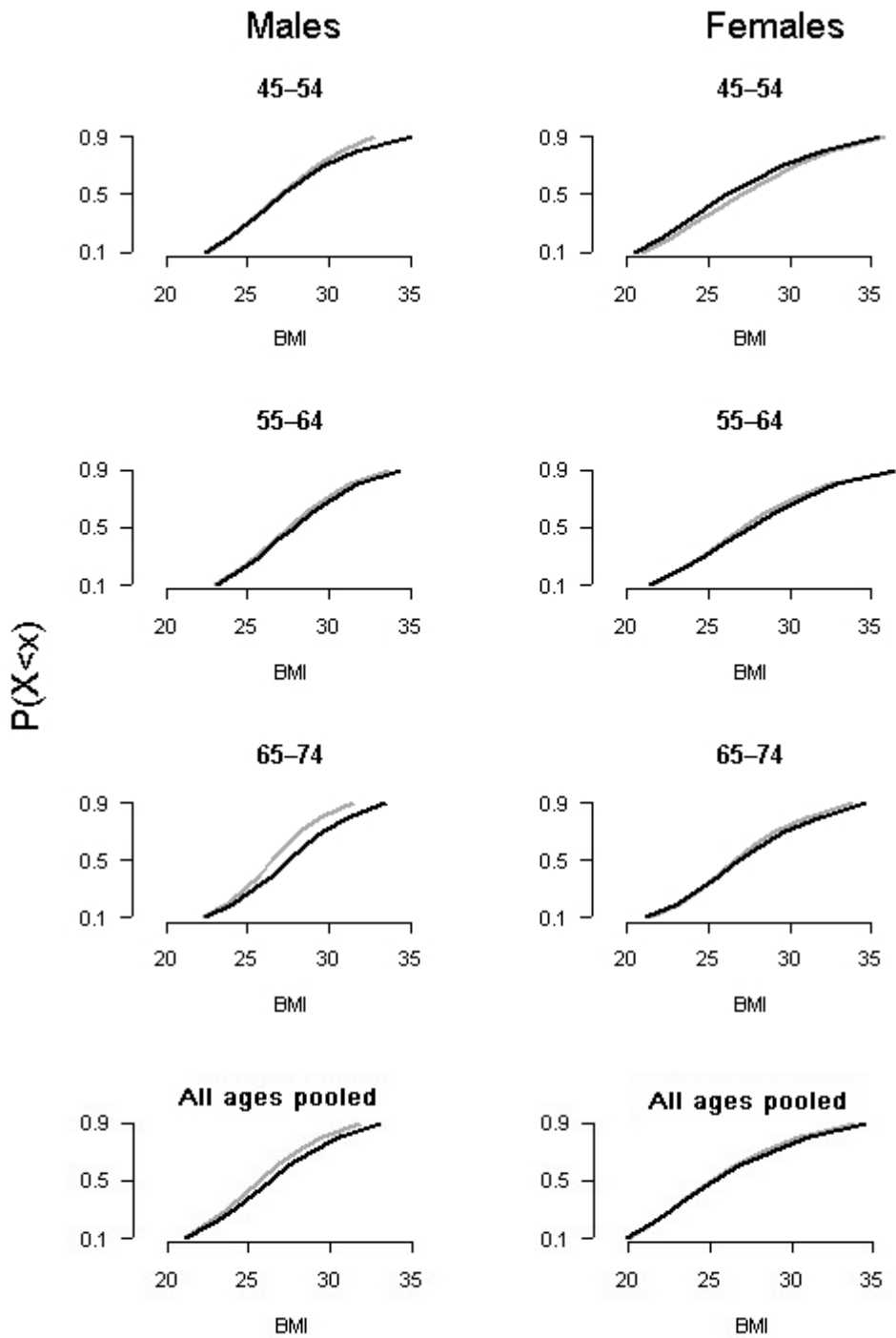




**Figure 22:** Cumulative distribution functions, 1997–2003

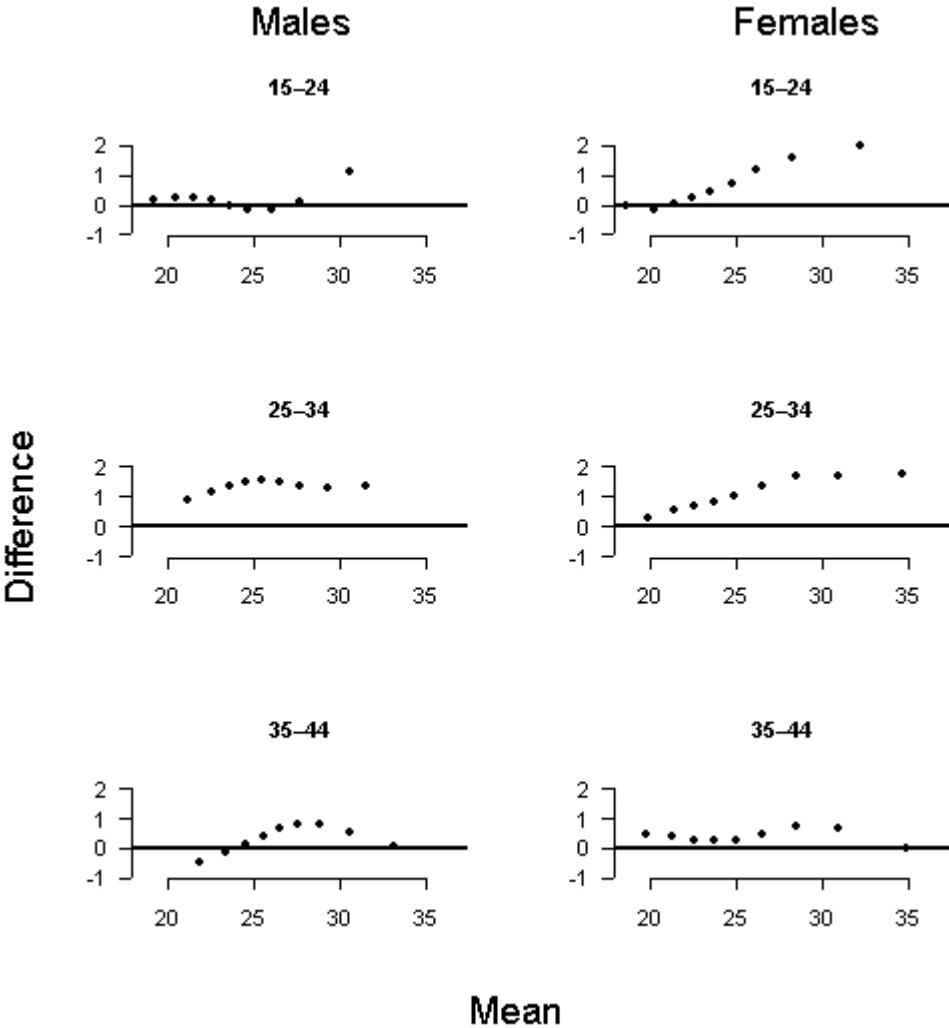


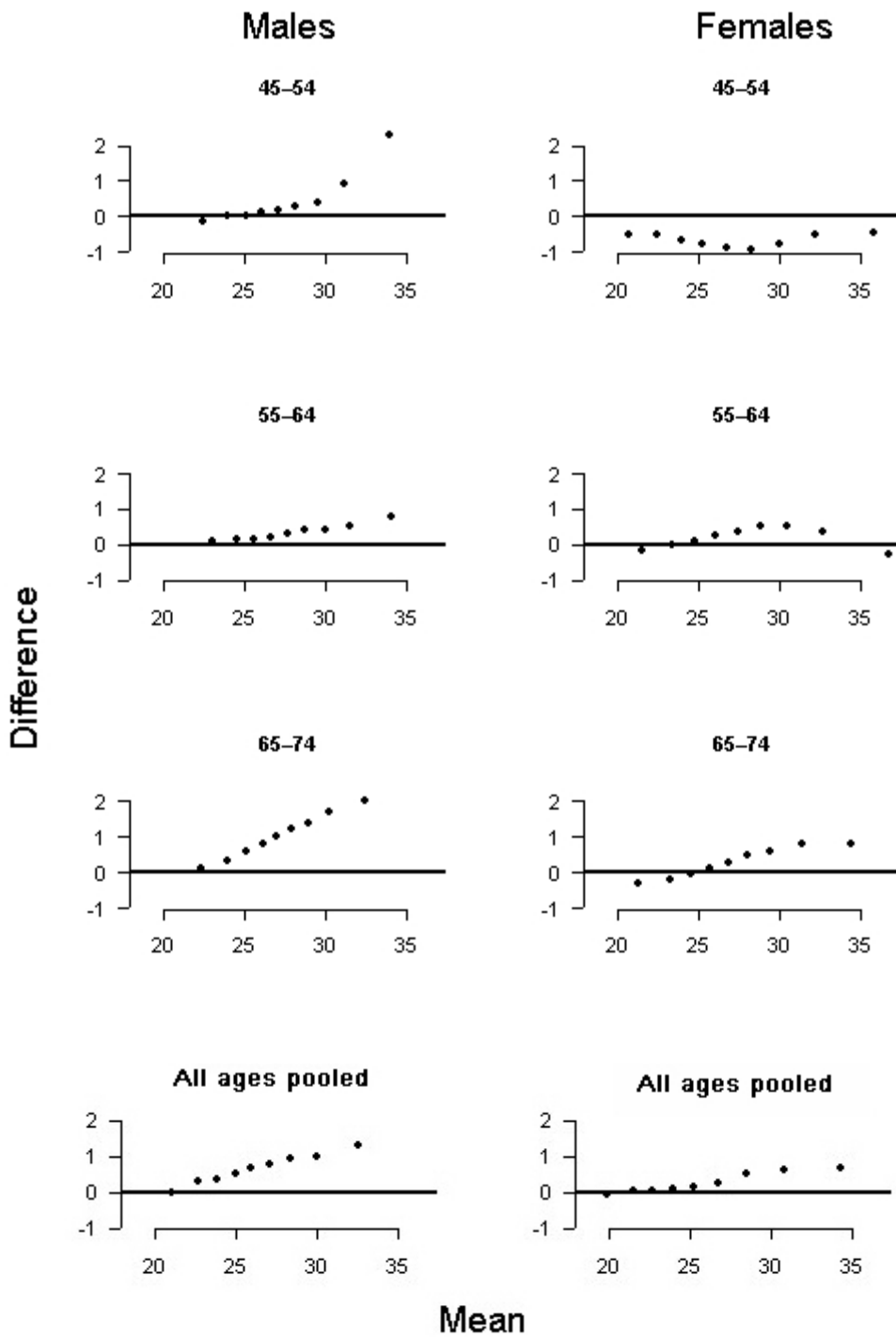
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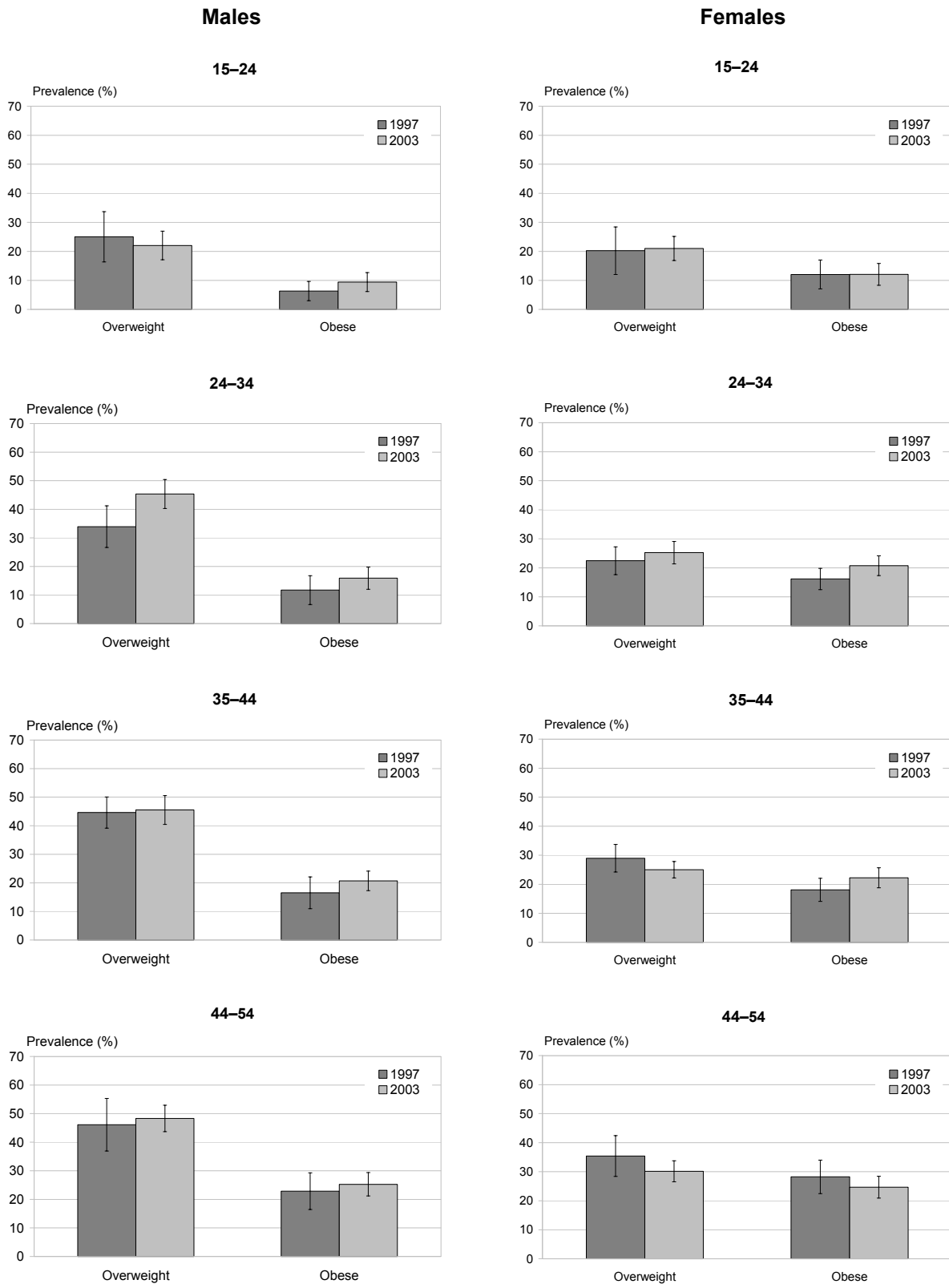
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Figure 23: Tukey mean difference plots 1997–2003



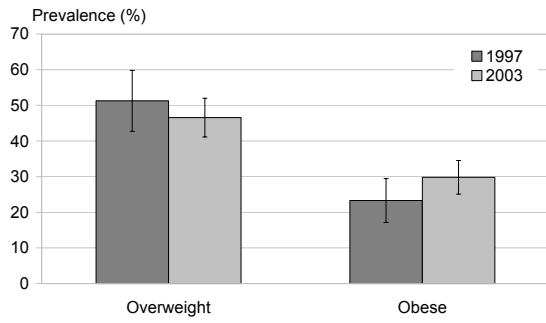


**Figure 24:** Prevalence of overweight and obesity, 1997–2003



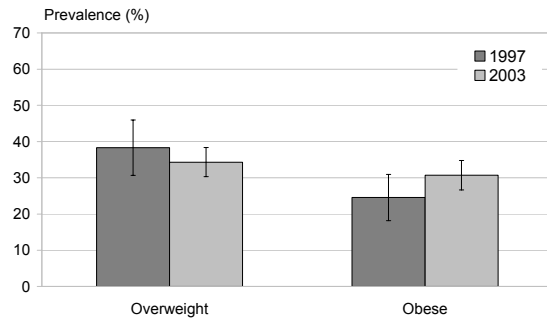
### Males

55-64

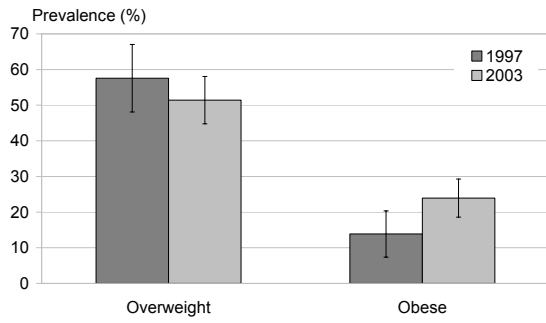


### Females

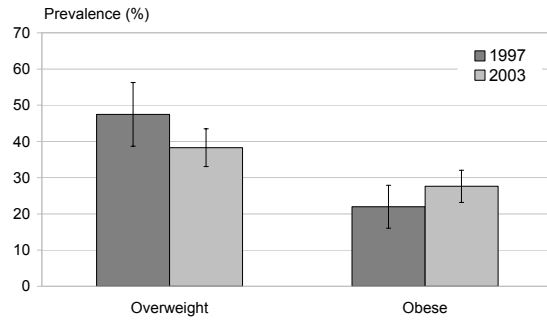
55-64



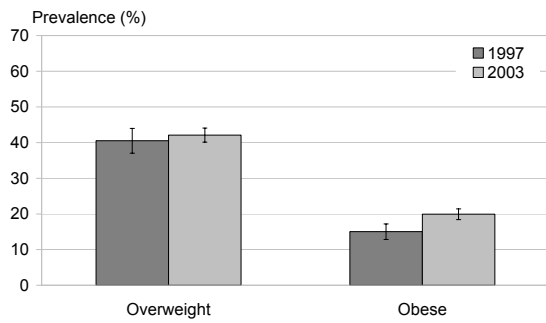
65-74



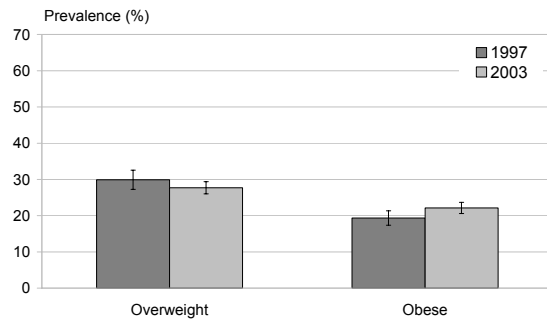
65-74



All ages pooled



All ages pooled





**Table 8:** Selected sample statistics, by 10-year age group (males), 1997–2003

Statistic	Year	15–24	25–34	35–44	45–54	55–64	65–74	All ages*
Mean BMI	1997	24.2	25.5	26.9	27.5	27.8	26.6	26.2
	2003	24.4	26.6	27.2	28.1	28.3	27.7	26.9
	AAPC*	0.19	0.74	0.22	0.37	0.31	0.66	0.41
Median BMI	1997	23.4	24.9	26.0	26.5	27.0	26.3	25.7
	2003	23.2	26.3	26.6	27.1	27.8	27.5	26.3
	AAPC*	-0.15	0.92	0.35	0.38	0.47	0.72	0.42
Overweight (%)	1997	25.0	33.9	44.6	46.1	51.3	57.6	40.5
	2003	21.6	45.3	45.2	48.3	46.5	51.6	42.1
	AAPC*	-2.46	4.94	0.24	0.78	-1.60	-1.80	0.65
Obese (%)	1997	6.3	11.7	16.5	22.9	23.3	13.9	15.0
	2003	10.6	16.1	20.7	25.4	29.7	23.9	19.9
	AAPC*	9.06	5.50	3.82	1.75	4.13	9.54	4.80

\* Average annual percentage change; assumes linearity.

**Table 9:** Selected sample statistics, by 10-year age group (females), 1997–2003

Statistic	Year	15–24	25–34	35–44	45–54	55–64	65–74	All ages*
Mean BMI	1997	24.1	25.3	26.1	27.9	27.8	27.2	26.2
	2003	24.3	26.2	26.6	27.3	28.1	27.6	26.4
	AAPC*	0.14	0.60	0.36	-0.41	0.18	0.26	0.16
Median BMI	1997	22.8	23.8	24.9	27.1	26.7	26.3	25.0
	2003	23.0	24.5	24.9	25.9	27.1	26.9	25.2
	AAPC*	0.17	0.48	0.03	-0.77	0.23	0.40	0.16
Overweight (%)	1997	20.2	22.4	29.0	35.4	38.3	47.5	29.9
	2003	20.9	25.3	25.4	29.4	33.7	38.3	27.7
	AAPC*	0.56	2.02	-2.19	-3.05	-2.10	-3.50	-1.27
Obese (%)	1997	12.0	16.2	18.1	28.2	24.6	22.0	19.4
	2003	12.4	21.6	23.2	26.5	30.9	28.0	22.1
	AAPC*	0.42	4.99	4.21	-1.05	3.88	4.14	2.25

\* Average annual percentage change; assumes linearity.

While both mean (and median) BMI and the prevalence of obesity continued to increase, the rapid rate of acceleration of the epidemic seen in the second period (1989–1997) appeared to slow in the third period (1997–2003), at least among females. Among males, the average annual percentage increase in obesity prevalence decreased marginally (if at all) from 5.5 to 4.8 percent, while among females the epidemic growth rate decreased more substantially, from 5.6 to 2.3 percent. Thus the prevalence of obesity continued to increase – from 15 to 20 percent among males and from 19 to 22 percent among females – but this was less than expected based on previous trends (ie, 1989–1997). Had the AAPC remained stable at its second-period level, the prevalence of obesity in 2003 would have been 21 percent among males (rather than the 20 percent observed) and 27 percent among females (rather than the 22 percent observed).

Still, the absolute increase in obesity prevalence over the period remains substantial. Among males, increases were most marked at both ends of the age spectrum (ie, the 15–24 and – for the first time – the 65–74 years age group), while among females all age groups showed a fairly uniform increase except for the 45–54 years age group.

For both genders, little change was seen in the prevalence of overweight. Overall, this increased slightly among males (from 40.5 to 42.1 percent), and declined slightly among females (from 29.9 to 27.7 percent). The prevalence of overweight decreased in all age groups except the two youngest age groups among females, and in the 15–24, 55–64 and 65–74 years age groups among males.

Examining the full BMI distributions (eg, using m–d plots), the most noticeable finding is how little change has occurred in all percentiles for most age groups. Among males, most age groups show small but typical patterns of increased skewness at heavier percentiles, but generally less than 2 BMI units even at the 90th percentile, (except for the 45–54 and 65–74 years age groups). Very little change is seen in the 55–64 years age group, and the 35–44 years age group shows an anomalous pattern with a small change in the middle percentiles and little change at either end of the distribution.

Among females the pattern is generally similar, with little change in the 15–24 years age group, a uniform shift in the 25–34 years age group, a somewhat anomalous pattern in the 35–44 years age group (similar to the males), and little change at any percentile in the 55–64 and 65–74 years age groups. The (female) 45–54 years age group is the first and only to show an actual decrease in the prevalence of obesity (from 28 percent in 1997 to 26.5 percent in 2003). No such decline is seen in any other age group, or among males.

In summary, the epidemic continued to grow in this most recent period (1997–2003), with mean BMI increasing 0.7 units among males and 0.25 units among females, although more slowly than it did from 1989 to 1997, at least among females (in most if not all age groups).

This pattern of change in the epidemic growth rate, affecting many age groups simultaneously (as opposed to a single birth cohort), is highly suggestive of a ‘period effect’. Possible explanations for this welcome if unexpected period effect will be discussed later.

## **Overview of BMI distributional shifting, 1977–2003**

We now briefly review the evolution of the epidemic over the whole study period again, this time emphasising variations in its time course between periods (1977–1989, 1989–1997, 1997–

2003), age groups and genders. Age-specific analyses were restricted to adults (25–64 years) as data are missing for youth (15–19 years) in the first period, and relatively little shift has occurred in the BMI distribution among older people (65+ years).

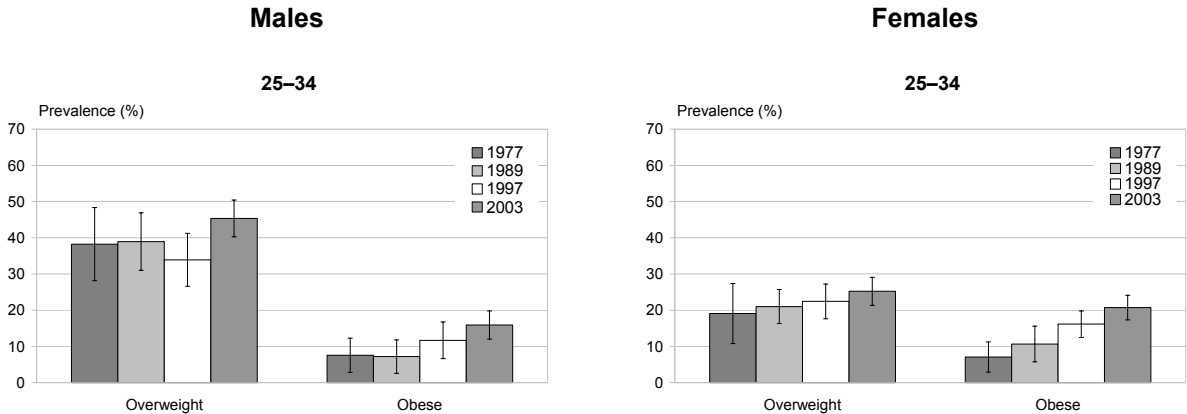
**Trends in overweight and obesity**

The changes in overweight prevalence have been small in both genders overall, although more variable across individual age groups (Figure 25). For females, the increase in overweight prevalence has been slightly higher than for their male counterparts. Yet more recently (1997–2003), overweight prevalence has fallen slightly again in all female age groups except the youngest.

However, the prevalence of obesity has increased steadily, particularly among the middle-aged and during the 1989–1997 period. The increase in obesity prevalence has been similar in both genders in relative terms (slightly more than doubling over the study period). The *rate* of increase in obesity prevalence appears to have declined in the most recent period (1997–2003) among females, but has decreased only slightly (if at all) among males.

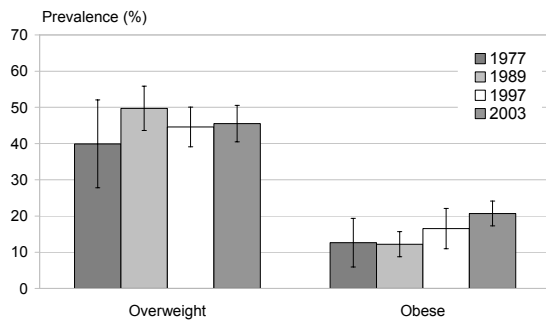
This pattern of increasing obesity but stable overweight prevalence overall suggests that it is individuals at the heavier end of the BMI distribution who are experiencing the greatest change in weight. In other words, the most substantive increases in BMI are occurring among the heaviest individuals in the population: more people are becoming obese, and those already obese are becoming even more obese (on average). As a result, the proportion of normal weight adults has declined by about one-fifth, while that of overweight adults has remained stable, and that of obese adults has more than doubled.

**Figure 25:** Prevalence of overweight and obesity, 1977–2003

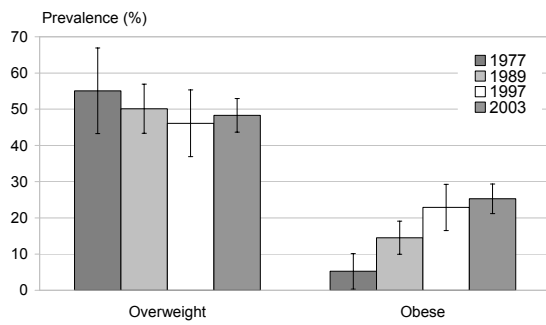


### Males

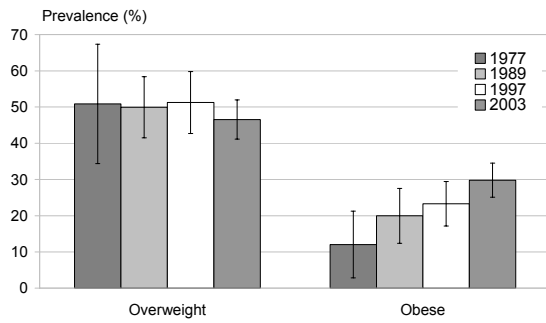
35–44



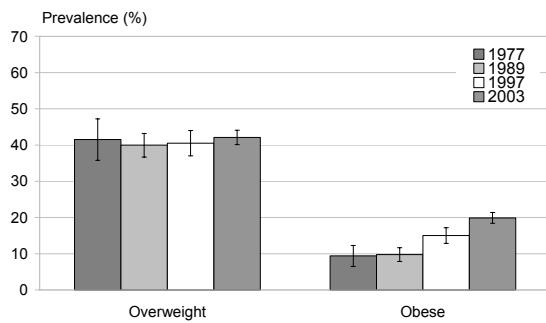
44–54



55–64

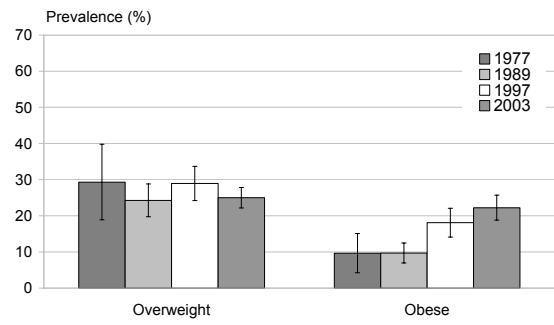


Ages pooled\*

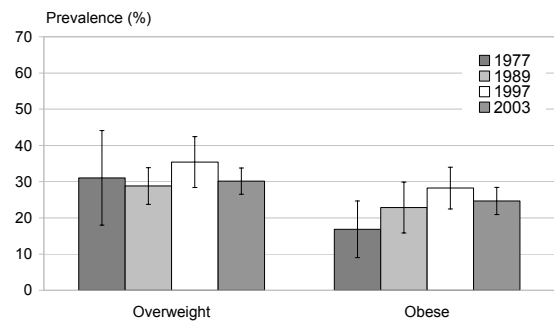


### Females

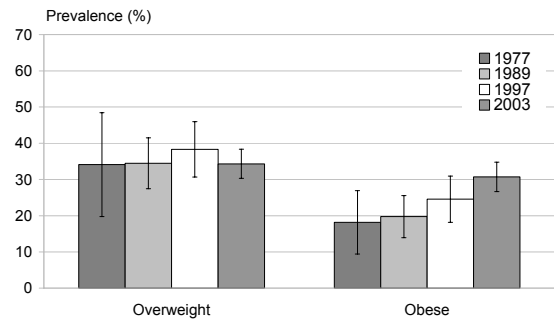
35–44



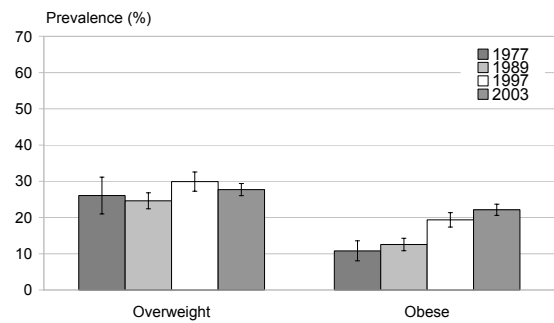
44–54



55–64



Ages pooled\*



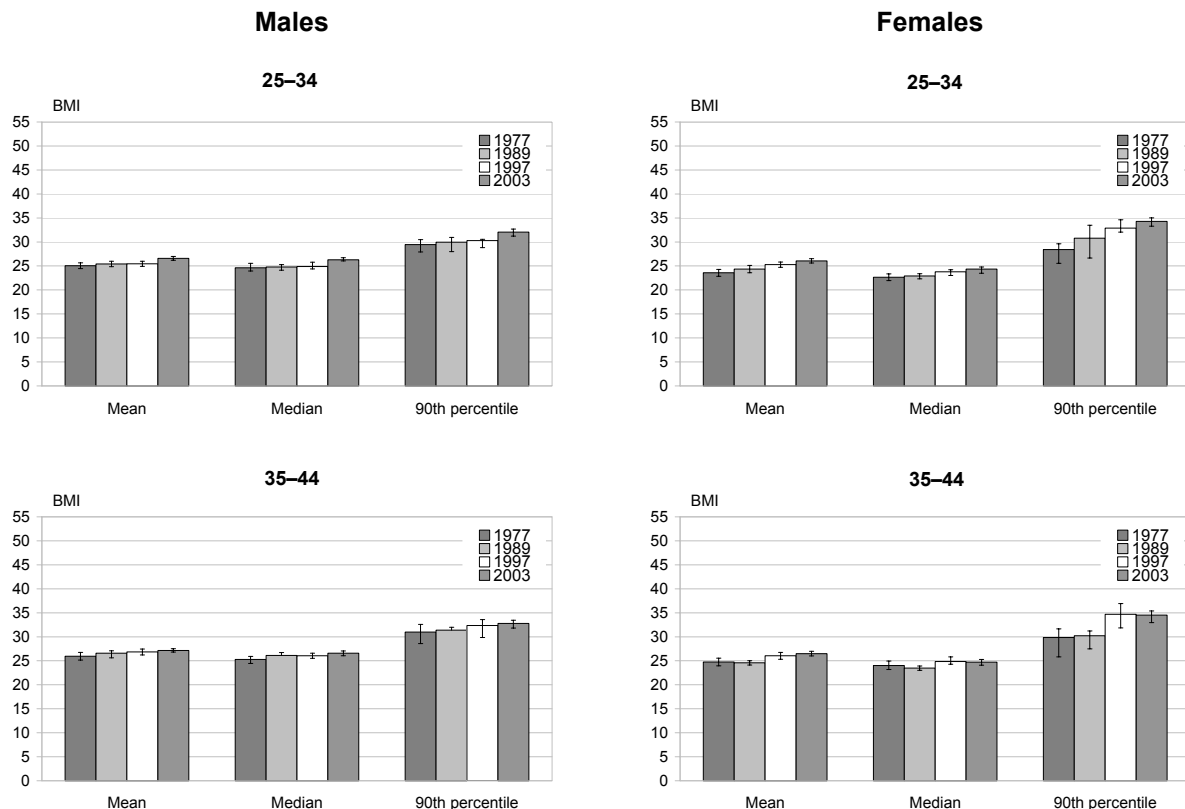
\* 20–64 years for 1977, 15–74 years for 1989–2003.

## Trends in BMI distributions

The increases in mean and median BMI have been much less dramatic than the increases in the 90th percentile across all age groups and both genders. The increases in mean and median BMI have been higher in middle-aged individuals than in other age groups, yet even this increase is relatively small compared to the trends in the 90<sup>th</sup> percentile in this age group (Figure 26). This is further evidence in support of the ‘mixed’ model (increasing skewness of the BMI distribution, implying a person–environment interaction), where the most significant changes involve the heaviest percentiles.

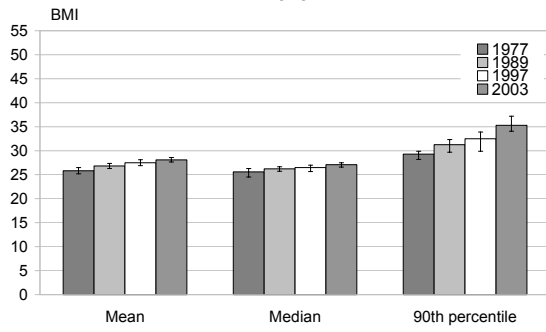
From the m–d plots it can be seen that the greatest increases in the 90th percentile occurred from 1989 to 1997, with smaller increases (most age groups) thereafter – again indicating the acceleration of the epidemic in the second period, followed by a *relative* deceleration more recently. That is, the epidemic has not yet peaked, but is no longer growing as fast as it did from 1989 to 1997, at least among females.

**Figure 26:** Trends in BMI (mean, median and 90th percentile), 1977–2003



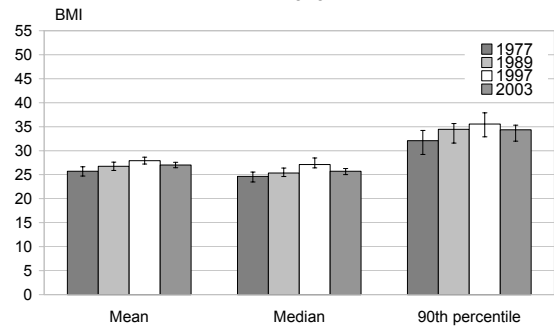
## Males

### 45-54

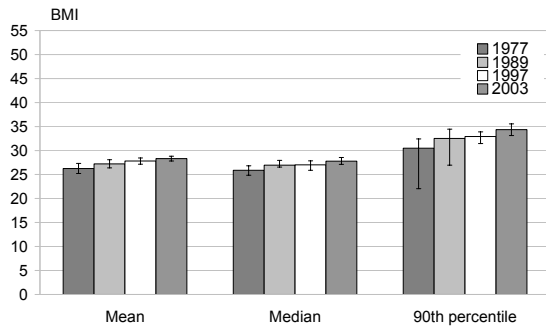


## Females

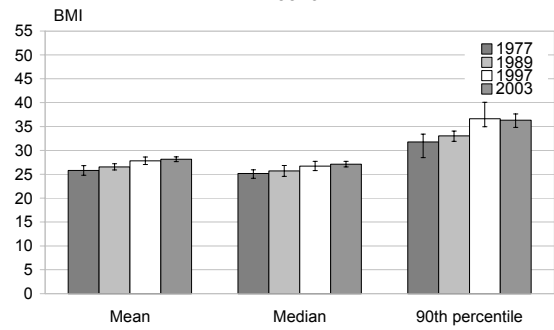
### 45-54



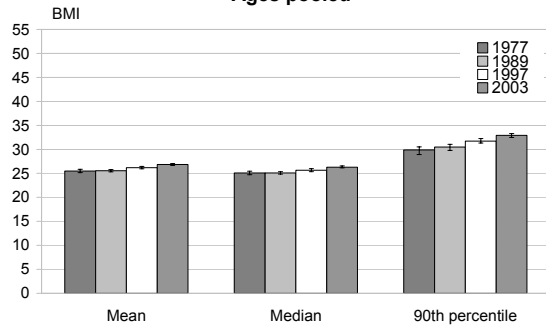
### 55-64



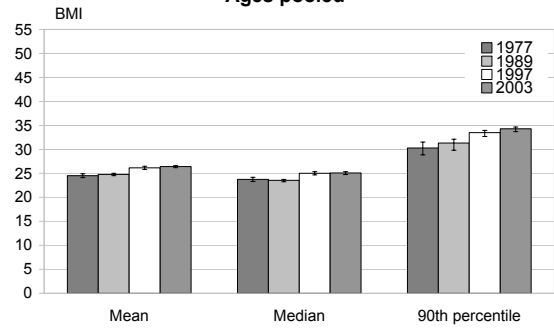
### 55-64



### Ages pooled\*



### Ages pooled\*



\* 20-64 years for 1977, 15-74 years for 1989-2003.

## Trends in the epidemic growth rate

While the AAPCs (epidemic growth rates) for mean or median BMI, and for overweight prevalence, are relatively small, this is not the case for obesity prevalence. The latter is also of most policy relevance, and so is briefly highlighted here (Figure 27). Note that confidence intervals are difficult to calculate for AAPCs; however, large changes are likely to be significant.

**Figure 27:** AAPC in obesity prevalence, total population, by period and gender

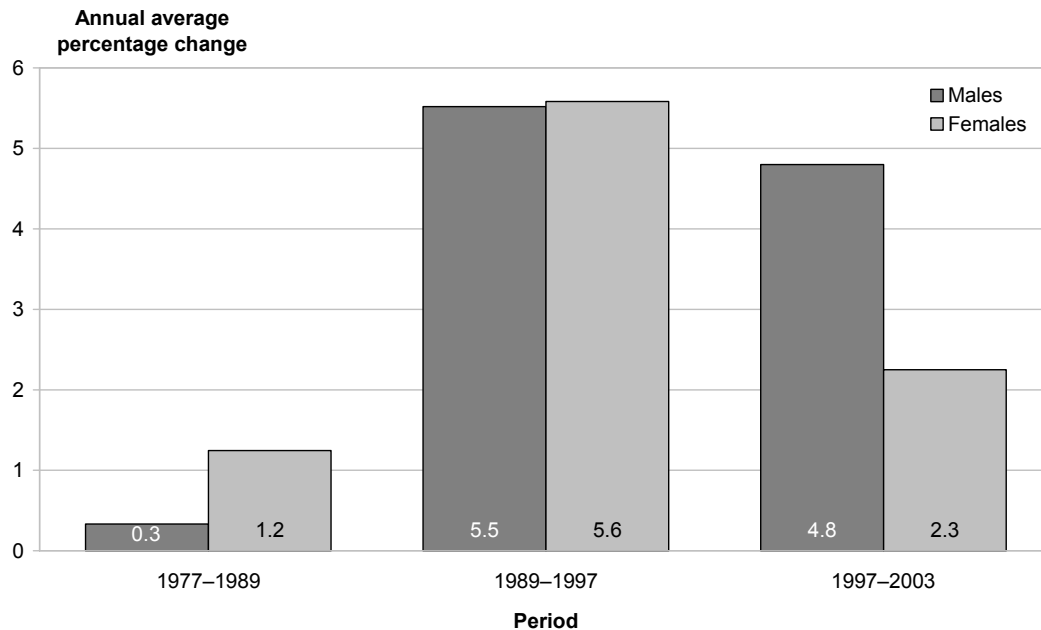


Figure 27 clearly demonstrates that the rate of growth of the epidemic has not been stable over the study period, so the average growth rate calculated for the entire period (3 percent per year for both genders, ages pooled) disguises substantive differences between periods.

Instead, the epidemic grew at a relatively slow rate during the first period (1977-1989), although more rapidly among females than males. The growth rate then accelerated sharply during the second period (1989-1997), when it grew at over 5.5 percent per year in both genders.

Since then a slight deceleration may have occurred during the third period (1997-2003) for males, among whom the epidemic has continued to grow at a rate of 4.8 percent per year (at least to 2003). However, among females, the growth rate of the epidemic appears to have clearly decelerated during the third period to a rate of 2.3 percent per year, compared to 5.6 percent in the preceding period. *Again, however, it needs to be emphasised that artefact resulting from differences in survey design and fielding cannot be excluded as a possible explanation for the apparent trend.*

## **Age- and ethnicity-standardised analysis**

A full understanding of the BMI trends requires examination of the data by age, cohort and period, as presented in earlier sections of this report. Crude age-pooled results have, however, also been presented as a summary measure. Yet these overall (age-pooled) estimates do not take the changing age structure of the New Zealand population into account.

To estimate the contribution of the ageing population to the observed trends in the BMI distribution over the past quarter century, we have repeated the analyses after standardising the distributions for age (using the direct method of standardisation, with the WHO world population as the reference) within the 25–64 years age range.

In brief, there is little difference between the crude and age-standardised results, indicating that the evolution of the epidemic in the total population over the past quarter century has been little affected by the population's changing age structure (data not shown).

Similarly, the total population analysis was repeated after standardising the BMI distributions for both age and ethnicity (using the 2001 Census population as the standard for the latter). Again, the results were little different from the crude analysis, indicating that changes in ethnic mix have not contributed noticeably to the observed shifts in the total population's BMI distribution (data not shown).