Contents

Appendix 4

The determinants of weight gain and weight maintenance ('energy balance')

EVIDENCE SUMMARY TABLES

EVIDENCE TABLE 1: MAINTAINING ENERGY BALANCE IN CHILDREN

SUMMARY

1.1 Dietary factors

Of the eighteen cohorts of children, ten longitudinal cohorts examined the association of dietary factors with weight change and one cross-sectional study (McConahy 2004) focused on portion size.

O'Loughlin et al. (2000) conducted a 2-year cohort study in 9–12-year-old children in Canada and reported no strong or consistent pattern of associations in either boys or girls for diet indicators and weight change (results not reported). Bogaert et al. (2003) conducted an analysis of 59 8-year-old Australian children and found no significant correlations between body mass index (BMI) over 12 months for any dietary variable.

Klesges et al. (1995) conducted a 2-year analysis of 3–5-year-old children and their parents in Tennessee and found that higher baseline percentages of energy as fat were associated with greater increases in BMI (0.168 kg/m^2 per 5%) and recent increases (year 2–3) in percentage of energy intake as fat were associated with greater increases in BMI (0.201 kg/m^2 per 5% change). Neither baseline total energy nor change in total energy increased variance in change in body mass.

The Growing Up Today Study (Berkey, 2000, 2003a, 2003b, Berkey 2005; Field, 2003, 2004; Taveras 2005) of 9–14-year-old US children included analyses of several potential determinants. Berkey et al. (2003) conducted an analysis of more than 10,000 children over 1 year and reported that for both boys and girls a larger rise in energy intake predicted larger BMI increase (girls 0.0059 per increase of 100 kcal [420 kJ]/day, boys 0.0082) and annual BMI increases were higher in girls with higher energy intakes (BMI increased by 0.061 kg/m^2 per 100 kcal [420 kJ]/day; $p > 0.02$). Over 2 years, boys with energy intake that increased more from the first to the second year predicted larger increases in BMI. In boys and girls no significant associations were noted for energy adjusted dietary fat or fibre and change in BMI ($p > 0.05$).

Overweight children who never ate breakfast lost BMI over 1-year compared with children who ate breakfast nearly every day (boys –0.66 kg/m^2, girls –0.50 kg/m^2). Normal weight children who never ate breakfast gained weight relative to peers who ate breakfast nearly very day (boys 0.21 kg/m^2, girls 0.08 kg/m^2).

Field (2003) conducted an analysis of more than 15,000 children over 3-years and after controlling for Tanner stage of development, age, height change, activity and inactivity (predictors of BMI), girls showed no relation between intake of fruits, fruit juice or vegetables (alone or combined) and subsequent changes in BMI *z*-score. In boys, intake of fruit and fruit juice was not predictive of changes in BMI. Although vegetables intake was inversely related to changes in BMI *z*-score ($p > 0.05$) after adjusting for energy intake, the magnitude of the effect was diminished and no longer significant.

There was no relation between intake of snack foods and subsequent changes in BMI *z*-score among the boys ($\beta = -0.004$), but snack foods had a weak inverse association ($\beta = -0.007$, $p > 0.05$) with weight change among the girls. However, the results were confounded by dieting status, which had a significant positive independent association with BMI change. After controlling for dieting status and whether the mother was overweight, the association between servings per day of snack foods and subsequent changes in BMI *z*-score were not significant in either gender (Field 2004).

Berkey (2005 GUTS) looked at the association between milk, dietary fat, dietary calcium and weight gain in the Growing Up Today Study (GUTS). Children who reported higher total milk intake experienced larger weight gains; children who drank more 1% and skimmed milk had larger weight gains than those who drank smaller amounts of 1% and skimmed; dietary calcium intake was positively correlated with weight gain; and dietary fat was not. The effects of milk and dietary calcium appeared to be explained by energy intake; however skimmed milk intake in girls remained marginally significant after adjustment for energy intake.

Taveras (2005, GUTS) looked at the association between overweight and frequency of family dinner in the Growing Up Today Study (GUTS). Whilst cross-sectional data showed children were less likely to be overweight if they ate dinner most days with their family, this relationship was not apparent in the longitudinal analyses over 2 years. This data was self-reported.

In the study by Thompson (2004) of girls (median age 9 years at baseline and followed for a median of 6 years), girls who ate quick-service food twice per week or more at baseline had the greatest means increase in BMI *z*-score at follow-up, and this change was significantly different from that seen in girls who ate quick-service food once or twice per week or not at all.

Burke (2005) investigated the relationships between different food categories and BMI at 8 years in 340 Australian children. Parents completed a food frequency questionnaire for their children at 6 years. An inverse relationship was found for ‘cereals’ and ‘% energy from total fat’ (p = 0.046 and p = 0.025 respectively) and a positive relationship with ‘takeaways’ (p = 0.025).

Elgar (2005) found that skipping meals and snacking (not further defined) were associated with obesity, but did not predict change in BMI between the ages of 11-12 and 15-16 years in 355 Welsh adolescents.

Moore (2003) investigated the relationships between physical activity level, TV viewing and change in body fat in 106, 3-5-year-olds from the Framingham Children’s Study over a period of eight years (from 2-5 years of age). Children with high fat diets (>34% calories from fat) exacerbated body fat gain in children watching TV for more than 3 hours per day. They gained approximately 30mm of body fat (sum of five skinfolds) compared with children who watched least TV (<1.75h per day) and consumed a lower-fat diet (<34% calories from fat).

Phillips (2004) investigated the relationship between energy dense snacks (EDS) and BMI z-scores in 196 non-obese pre-menarcheal girls 8 to 12 years old from the Massachusetts Institute of Technology Growth and Development Study (ethnicities included 75% white, 14% black and 11% other races) for four years after menarche. Categories of EDS foods considered were baked goods, ice cream, chips, sugar-sweetened carbonated drinks and sweets. No relationship was found between BMI z score or % body fat and total EDS food consumption. However, carbonated drinks were the only EDS food significantly related to BMI z-score over the 10-year study period (p-value for trend <0.001), but it was not related to % body fat.

Reilly (2005) examined 25 risk factors for obesity from the inter-uterine period to 7 years in the ALSPAC cohort (UK). Eight factors were associated with risk of obesity. None were dietary, although a ‘junk food type dietary pattern’ (not defined further) at 3 years was significant at the 10% level.

McConahy (2004) looked at dietary behaviours in 5447 children aged 2-5 years from the Continuing Survey of Food Intakes by Individuals across the US, over a two year period. Based on parental self-report, this cross-sectional study found that body weight, food portion size, number of eating occasions and number of foods accounted for 38% of the variance in 2-3-year-olds and 39% in 4-5-year-olds. Portion size as a single predictor explained 17% of the variance in 2-3-year-olds and 19% in 4-5-year-olds.

1.2 Physical activity

Of the eighteen cohorts of children, eight cohorts examined the association of physical activity (PA) factors with weight change. O’Loughlin et al. (2000) reported 1-year predictors of higher decile of change in BMI included no sports outside school (odds ratio [OR] 1.90; 95% confidence interval [CI] 1.18, 3.06) in girls. Two-year predictors of higher decile of change in BMI included no sports outside school (OR 2.14; 95% CI 0.96, 4.77) and least active (OR 2.18; 95% CI 1.01, 4.71) in boys.

Berkey et al. (2003) reported annual BMI increases were higher in girls with fewer hours of activity (BMI decreased by 0.284 kg/m^2 per hour per day of activity; $p > 0.05$) during the year between baseline and follow up. Boys who marginally, had less PA (–0.0261 kg/m^2 per hour of activity; $p = 0.094$) showed larger annual BMI increases. The number of gym classes per week was not associated ($p > 0.10$) with change in BMI in boys. Boys with higher metabolic equivalent tasks (METs) during the year between the two BMIs had marginally smaller ($p = 0.6$) increases in BMI.

Klesges et al. (1995) reported that higher baseline aerobic activity and increased leisure activity from years 2 to 3 were associated with BMI decreases.

Bogaert et al. (2003) reported no significant correlations between BMI over 12 months for any measures of energy expenditure, including hours of television (TV) viewing or percentage of time spent in low, moderate or high intensity activity. A significant correlation was found between activity and weight change for mothers and girls for percent time in moderate to high activity ($r = 0.44$, $p = 0.03$) and between fathers and children for percentage of time spent in low activity ($r = 0.43$, $p = 0.005$).

Datar et al. (2004) conducted a 1-year follow-up of primary school aged children in the USA and examined association between weight change and PA only. The study found that one additional hour of physical education in the first grade compared with the time allowed for physical education in kindergarten reduced BMI among girls who were overweight or at risk for overweight in kindergarten (*p* > 0.01) but had no significant effect among overweight or at risk for overweight boys (*p* = 0.02) or among boys (*p* = 0.31) or girls (*p* = 0.80) with a normal BMI.

Moore (2003) examined 106 children aged 3-5 years from the Framingham Children's Study with Caltrac motion sensors to assess physical activity levels. Children were categorised as having low, medium or high activity levels (based on average number of counts per hour and then averaged over the eight year study period). Children in the highest tertile for daily physical activity had consistently smaller gains in BMI, triceps and sum of 5 triceps throughout childhood. By 11 years, sum of 5 skinfolds was 95.1mm, 94.5mm and 74.1mm for the low, medium and high tertiles respectively (p-value for trend = 0.045). This relationship was evident for both sexes. Children with the lowest levels of PA and highest levels of TV viewing gained nearly 40 mm of body fat than children with highest levels of PA and least TV by 11 years.

Burke (2005) used parental questionnaires to assess levels of physical activity in 1430 Australian children at 6 years. Playing organised sport at age 6 was not predictive of BMI at age 8, but 'being slightly active' and 'active' at 8 years were (OR 0.44; 95 CI 0.28, 0.70 (p<0.001) and OR 0.23; 95 CI 0.14, 0.38 (p<0.001)) respectively. Duration of physical activity was not reported.

Elgar (2005) assessed the relationship between physical activity and change in BMI in 355 Welsh adolescents who were part of the Health Behaviour of School-aged Children Study. Physical activity questions were from the HBSC questionnaire and hours of sports participation was associated with lower increases in BMI (p<0.05) over the four year period (from 11-12 to 15-16 years). Details about amount of hours of sport were not reported.

1.3 Other behavioural, psychological, social and environmental factors

1.3.1 Sedentary behaviours – television/video viewing

Ten cohorts examined the relationship between television (TV)/video viewing and weight change in children. Kaur (2003) analysed 3-year data from 12–17-year-old Californian adolescents and found that 1% variation in follow-up BMI% was explained by TV watching. Watching >2 hours TV per day was related to higher odds of being overweight at follow-up among adolescents at normal weight at baseline (OR 1.9; 95% CI 1.1, 3.5) and among adolescents overweight at baseline (OR 2.8; 95% CI 1.3, 6.3). For each additional hour of TV watching at baseline the average follow-up BMI% increased by 0.5, controlling for ethnicity and baseline BMI%. Forty-eight percent of new-onset overweight among adolescents not overweight at baseline was attributable to watching >2 hours TV per day.

O'Loughlin (2000) reported there was no strong or consistent pattern of association in either boys or girls for TV viewing. One-year predictors of higher decile of change in BMI included playing video games everyday (OR 2.48; 95% CI 1.04, 5.92) in girls.

Robinson (1993) conducted a 2-year analysis of 12-year-old Californian children and reported that hours of after-school TV viewing did not longitudinally predict change in ***sexual maturity index (SMI)*** -adjusted BMI (univariate Spearman *r* = 0.03, *p* = 0.62; multivariate regression co-efficient estimate = 0.05, *p* = 0.82). Hours of after-school TV viewing did not longitudinally predict change in SMI-adjusted triceps skinfold thickness (univariate Spearman *r* = 0.03, *p* = 0.54; multivariate regression co-efficient estimate = –0.19, *p* = 0.67).

Berkey (2003) reported that annual BMI increases were higher in girls with more hours of TV /video/games (BMI increased by 0.372 kg/m^2 per hour per day; *p* > 0.001) during the year between baseline and follow up. Boys who spent more time with TV/videos/games (0.384 kg/m^2 per hour per da***y***; *p* > 0.0001) showed larger annual BMI increases. Over 2 years, boys with higher means hours of TV/video/games were predicted to have larger increases in BMI.

Bogaert (2003) reported no significant correlations between BMI over 12 months for hours of TV viewing.

Burke (2005) examined the relationship between hours per day spent watching TV and BMI at 8 years with the Western Australian Pregnancy Cohort. Parental questionnaires were completed about their children's television viewing habits at age 6 and hours spent TV viewing at age 6 was predictive of BMI at 8 years; OR 1.53; 95 CI 1.16, 2.02 (p<0.002), ie more TV viewing resulted in higher BMI.

Elgar (2005) assessed the relationship between sedentary behaviour and change in BMI in 355 Welsh adolescents who were part of the Health Behaviour of School-aged Children Study. Sedentary behaviour (watching television or playing computer games) at Time 1 predicted BMI four years later ($p<0.05$), ie more sedentary behaviour resulted in higher BMI.

Moore (2003) used parental questionnaires in conjunction with Caltracs to estimate hours of TV viewing and video games per day in 106, 3-5-year-olds from the Framingham Children's Study. TV viewing was divided into tertiles of hours per day: <1.75h, 1.75 to <3.0h, >3.0h. At 11 years, those who watched 3.0h or more per day had a mean sum of 5 skinfolds of 106.2mm compared with 87.6mm for those watching 1.75 to <3.0h, and 76.5mm for those watching least ($p = 0.007$; p-value for trend = 0.028).

Reilly (2005) found two predictive factors for sedentary behaviours within the ALSPAC cohort. Watching more than 8 hours of television per week at age 3 was associated with risk of obesity (adjusted OR 1.55; 95 CI 1.13, 2.12) and short sleep duration (<10.5 hours) at age 3 was also identified as a risk (OR 1.45; 95 CI 1.10, 1.89).

Viner (2005) UK conducted an analysis of the 1970 British Birth cohort of over 8000 subjects followed up at 5, 10 and 30 years (30 year follow-up self-reported) examining the relationship between television viewing and BMI change. Weekend but not weekday TV viewing in early childhood independently predicted increased adult BMI.

Clearer relationships were found from ages 5 to 10 years than to 30 years. Mean hours of weekend TV and frequent TV watching at 10 were independently associated with higher BMI at 10: Using obesity at 10 as the outcome in logistic regression, each additional hour of TV watched on weekdays at 5 years increased the risk of obesity by 12% (OR 1.12; 95 CI 1.04, 1.21; $p = 0.002$); and each additional hour at weekends increased risk by 10% (OR 1.10; 95 CI 1.03, 1.18; $p = 0.003$).

1.3.2 Socio-economic status

Spiegelaere (1998) examined possible association between socio-economic status (SES) (statuses) and the rate of adiposity rebound in 3–5-year-old Belgium children and found that adiposity rebound before age 5 years was inversely related to body mass at age 3 years and was independent of social status. Parental income and education were not associated with change in BMI *z*-score in the study by Thompson et al. (2004).

Burke (2005) considered predictive factors for BMI at 8 years in 1430 Australian children. Categories of higher and lower incomes were based on total family income (categorised as lower = below $40,000, or higher = above $40,000). BMI was similar at 3 years but at 6 and 8 years, BMI was higher in lower income families ($p = 0.004$). A similar pattern was apparent for maternal education; BMI at 6 years was lower in tertiary educated mothers ($p = 0.001$) compared with mothers not educated beyond secondary schooling or having a technical qualification.

Elgar (2005) found that demographic factors and SES did not predict change in BMI in 355, Welsh adolescents (aged 11-14 years) over four years.

1.3.3 Age

Berkey (2003) examined the association between weight change and age and among boys under 12 years old, those who did more PA in the year between the BMI measurements had smaller annual increases in BMI (-0.0746 ± 0.0212).

1.3.4 Overweight biological parents

Klesges (1995) examined possible association between weight change and having one or two overweight biological parents. Boys with both parents overweight had increases in children's BMI (0.67 kg/m^2) and for girls those with just a father overweight showed BMI gains over 2 years (0.40 kg/m^2). O'Loughlin (2000) reported there were no strong or consistent pattern of associations in either boys or girls for family origin (results not reported). Parental BMI was not associated with change in BMI *z*-score in the study by Thompson et al. (2004).

Reilly (2005) found parental fatness was associated with risk of obesity at 7 years in the ALSPAC cohort. This was apparent if one parent was obese and increased If both parents were obese (OR 10.44; 95 CI 5.11, 21.32).

Burke (2005) looked at maternal weight and BMI in 1430, Australian 8-year-olds followed since 16 weeks gestation. BMI at 8 was predicted by maternal weight and maternal BMI and in a subset of 298 children with paternal data, each obese parent independently increased the risk of obesity at 8 by three times.

1.3.5 Birth weight

Reilly (2005) found four child weight related factors associated with obesity risk at 7 years in the ALSPAC cohort. Increasing birth weight was independently and linearly associated with obesity ($p<0.001$), as were early BMI or adiposity rebound (by 43 months) (OR 15.0; 95 CI 5.32, 42.3), catch-up growth (OR 2.6; 95 CI 1.09, 6.163) and weight gain in first year (OR 1.06; 95 CI 1.02, 1.10).

Burke (2005) also found that birth weight was positively associated with BMI at 8 ($p<0.001$) and an increasing likelihood of remaining overweight or obese with age.

1.3.6 Baseline body mass index

O'Loughlin (2000) reported that baseline BMI was the only consistent independent predictor of excess weight gain in all four multivariate models. One-year predictors of higher decile of change in BMI included BMI of 90th percentile or more (OR 2.66; 95% CI 1.80, 1.34) in boys and BMI of 90th percentile or more (OR 2.34; 95% CI 1.46, 3.76), in girls. Two-year predictors included baseline BMI of 90th percentile or more (OR 3.26; 95% CI 1.52, 7.01), and BMI of 90th percentile or more (OR 2.22; 95% CI 1.02, 4.81) in girls. Kaur (2003) reported nearly 50% variation in follow-up BMI% was explained by baseline BMI%.

1.3.7 Ethnicity

Two cohorts examined ethnicity and weight change, with one reporting that only 0.3% variation in follow-up BMI% was explained by ethnicity (Kaur 2003). Sixty-eight percent of the children were White, 5% African American, 20% Hispanic and 8% Asian with no other further details regarding ethnicity and weight change. Ambrosius (1998) performed a 14-year follow-up of children mean age 9–10 years at baseline (range 5–20 years) in Indianapolis. He reported that the rate at which BMI increased in Black children was significantly greater than in the White children ($p > 0.0001$). There were no gender differences in the rate of increase of BMI. No other details regarding ethnicity were reported.

1.3.8 Self-esteem

One cohort study examined the association between self-esteem and weight change in 12–15-year-old children in Minnesota (French 1996). Partial correlations were identified between baseline self-esteem and BMI at 3 years. In females, low physical appearance and low social acceptance self-esteem at baseline were associated with higher BMI 3 years later. In males, baseline self-esteem was unrelated to BMI 3 years later. Analyses examining relationships between baseline self-esteem and overweight status 3 years later showed high close friendship self-esteem in females and high physical appearance self-esteem in males were associated with decreased odds of overweight at 3-year follow-up. (All associations were significant but modest in magnitude.)

1.4 Parental fatness

A systematic review (Parsons et al. 1999) identified eight cohort studies that identified factors in childhood that may influence the development of obesity in adulthood. Offspring of obese parent(s) were consistently seen to be at increased risk of fatness, although few studies have looked at this relationship over longer periods of childhood and into adulthood. Data from one study suggested that this relationship may be stronger between mothers and their offspring than fathers and offspring, and that the mother-offspring relationship strengthens over time. One study found that parental obesity was a more important predictor of offspring obesity earlier in childhood (<6 years), becoming less important with increasing age. Data from another study showed that parental obesity influences tracking of the offspring's own obesity, which is much stronger if both parents are obese.

The relative contributions of genes and inherited lifestyle factors to the parent–child fatness association remains largely unknown.

1.5 Evidence of corroboration in the UK

Three of the 18 cohorts of children were conducted in the UK (Elgar 2005, Reilly 2005, Viner 2005) and the other cohorts were mainly conducted in the USA and generalisable to UK children. *(Evidence of implementation not valid for this review as not intervention studies.)*

EVIDENCE SUMMARY TABLES: DETERMINANTS OF WEIGHT GAIN/CONTROL IN CHILDREN

First author, design, aim	Population	Intervention details, length of follow-up	Results	Confounders adjusted for/comments
EVIDENCE OF ASSOCIATION BETWEEN DIETARY, PHYSICAL ACTIVITY AND OTHER FACTORS WITH WEIGHT CHANGE				
Parsons et al. (1999) **Aim:** To identify factors in childhood which may influence the development of obesity in adulthood 1++	Various, from eight cohort studies. **Baseline BMI:** Various.	**Year of baseline survey:** Various. **Duration of follow-up**: At least 1 year. **Outcome variable**: Measure of fatness. **Self-reported or measured weight:** Measured. **Statistical analysis**: Various.	Offspring of obese parent(s) were consistently seen to be at increased risk of fatness, although few studies have looked at this relationship over longer periods of childhood and into adulthood. Data from one study suggested that this relationship may be stronger between mothers and their offspring than fathers and offspring, and that the mother–offspring relationship strengthens over time. One study found that parental obesity was a more important predictor of offspring obesity earlier in childhood (<6 years), becoming less important with increasing age. Data from another study showed that parental obesity influences tracking of the offspring's own obesity, which is much stronger if both parents are obese. The relative contributions of genes and inherited lifestyle factors to the parent–child fatness association remains largely unknown.	**Adjusted for:** Various. **Author's conclusions:** Offspring of obese parent(s) were consistently seen to be at increased risk of fatness, and offspring of obese parents who themselves are fatter in childhood may be at particular risk.
Viner 2005 Prospective cohort, Aim: To examine the effects of duration, timing and type of television at 5 years on BMI in adult life.	1970 British Birth cohort of subjects (n = 16 567) living in Great Britain born 5-11th April, 1970. Cohort was representative of the UK population in childhood. At 30 years, 96.3% were white, 0.6% black, 1.8% South	Year of baseline examination and survey: Participants originally enrolled in the longitudinal growth and development study in 1970. Duration of follow-up: Participants were followed-up at 5, 10, 16, 26 and 29-30 years. Outcome variables:	**Attrition:** 32% **Weight change**: Obesity was found in 4.3% at 10 and 11.4% of the participants at 30 years. **Association of diet with weight change:** None reported. **Association of physical activity with weight change:** Higher frequency of playing sport at 10 years was independently associated with lower BMI z-score at 30: adjusted regression coefficient (95 CI) -0.08 (-0.12, -0.04; p<0.0001). **Association of other factors with weight change:** Higher duration of TV watching on weekdays and weekends were both	Adjusted for: Sex, social class, maternal education, birth weight, and BMI z-score of both parents. Also height at 5 and 10 years. Author's conclusions: Could not conclude that TV viewing in early childhood

	Asian, 0.8% Chinese and 0.6% other ethnic groups. At 5 years, data were obtained for 14,875 and 11,261 were interviewed at 29-30. Complete data on 8158.	Change in BMI z-score, calculated from the revised UK 1990 growth reference. Self-reported or measured: Both self-reported and measured. Height and weight measured by health care professionals at and 10 years. Self-report at 30 years. Statistical analysis: Linear regression and multivariate regression models.	significantly associated with higher BMI z-scores at 10 and 30 years. Mean hours of weekend TV and frequent TV watching at 10 were independently associated with higher BMI at 10: Using obesity at 10 as the outcome in logistic regression, each additional hour of TV watched on weekdays at 5 years increased the risk of obesity by 12% (OR 1.12; 95 CI 1.04, 1.21; p = 0.002); and each additional hour at weekends increased risk by 10% (OR 1.10; 95 CI 1.03, 1.18; p = 0.003). Strong maternal beliefs that TV was harmful to children at 5 years, predicted lower viewing at 10 years (p<0.001). Results at 30 years Mean daily hours of TV viewed at weekends predicted higher BMI z-score at 30 years (coefficient=0.03, 95% CI: 0.01, 0.05, P=.01) when adjusted for TV viewing and activity level at 10 years, sex, socioeconomic status, parental BMIs, and birth weight. Each additional hour of TV watched on weekends at 5 years increased risk of adult obesity (BMI > or =30 kg/m2) by 7% (OR=1.07, 95% CI 1.01, 1.13, P=.02). Weekday viewing, type of program and maternal attitudes to TV at 5 years were not independently associated with adult BMI z-score.	directly attributes to increased BMI.
Reilly 2005 Prospective cohort ALSPAC **Aim: To identify risk factors in early life for obesity in children**	8234 children aged 7 years and a sub-sample of 909 children with data on early growth related risk factors for obesity from the UK (Avon Longitudinal Study of Parents And Children). The original cohort of children was 13,971.	Year of baseline survey: April 1991 to December1992 Outcome variable: BMI. Duration of follow-up: 7+ years. Self-reported or measured weight: Measured. Statistical analysis: Multivariable binary logistic regression models in three stages. X^2 tests used for linear trend for ordered categorical	**Attrition:** 43% **Weight changes:** Increasing birth weight was independently and linearly associated with obesity (p<0.001); early adiposity rebound (by 43 months) (OR 15.0; 95 CI 5.32, 42.3); catch-up growth (OR 2.6; 95 CI 1.09, 6.163) and weight gain in first year (OR 1.06; 95 CI 1.02, 1.10). **Association of diet with weight change:** Food frequency questionnaires at 30 and 38 months, but dietary patterns at 3 years were not associated with risk of obesity at 7 years. Although in the final adjusted model, a 'junk food' diet reached significance at the 10% level. **Association of physical activity with weight changes:** No analysis. **Association of other factors with weight changes:** Watching more than 8 hours of television per week at age 3 was associated with risk of obesity (adjusted odds ratio 1.55; 95 CI 1.13, 2.12). Short sleep	Adjusted for: Maternal education, interuterine and perinatal factors, infant feeding and complementary feeding, family demography and lifestyle in early childhood. Author's conclusions: Early life environment implicated in findings. Interventions

<table>
<tr><td></td><td></td><td>variables.</td><td>duration (<10.5 hours) at age 3 was also identified as a risk (1.45, 1.10 to 1.89).

Parental obesity was associated with risk of obesity and when both parents obese (10.44; 5.11, 21.32). Maternal smoking between 28 and 32 weeks gestation was significantly associated with risk of obesity (independent of maternal education) at all intensities of smoking eg >20 (1.80, 1.01, 3.39). There was some evidence of a dose response relationship (X^2 test for linear trend 27.17).</td><td>might focus on environmental changes for short periods attempting to modify factors in utero, infancy or early childhood.</td></tr>
<tr><td>Elgar 2005

Prospective cohort

Aim: To investigate the effect of sedentary behaviour and physical activity on changes in body mass</td><td>355 adolescents from the Health Behaviour of School-aged Children Study in Wales.

Mean age at baseline was 12.30 (SD = 6.30).</td><td>Year of baseline survey: 1994

Outcome variable: Change in BMI.

Duration of follow-up: 4+years.

Self-reported or measured weight: Measured.

Statistical analysis: Multiple regression was used for BMI predictors.</td><td>Attrition: 45.5%

Weight changes:
There were no significant changes in prevalence of overweight and obesity over the four year period for either sex.

Association of diet with weight change:
Analyses showed skipping meals and snacking were associated with obesity, but were not predictive of BMI change.

Association of physical activity with weight changes:
Hours of sports participation was associated with lower increases in BMI (p<0.05).

Association of other factors with weight changes:
Sedentary behaviours at 11 years predicted BMI at 15 years (p<0.001), but did not influence change in BMI over four years.

Demographic and SES did not predict change in BMI at 15 years, but amount of pocket money earned did (p<0.05).</td><td>Adjusted for:
BMI at 11 years

Author's conclusion:
Sedentary behaviour and physical activity in early adolescence influenced body mass in late adolescence.</td></tr>
<tr><td>Burke 2005

Prospective cohort

Aim: To examine predictors of BMI at age 8 years</td><td>741 boys and 689 girls followed from 16th week of gestation from the Western Australia Pregnancy Cohort Study.

The original</td><td>Year of baseline survey: May 1989 to November 1991

Duration of follow-up: 8+ years.

Outcome variable: BMI.

Self-reported or</td><td>Attrition: 33%

Weight changes:
Table shows percentages of overweight (including obese) using the IOTF definitions.
<table><tr><th>Age (years)</th><th>Boys</th><th>Girls</th></tr><tr><td>1</td><td>22.1</td><td>25.1</td></tr><tr><td>3</td><td>13.5</td><td>14.0</td></tr><tr><td>6</td><td>12.6</td><td>17.9</td></tr></table></td><td>Adjusted for:
sex and maternal education

Authors conclusions:
Important to recognise role of adverse health-related</td></tr>
</table>

<table>
<tr>
<td rowspan="2"></td>
<td>cohort of children was 2087.</td>
<td rowspan="2">measured weight: Measured.

Statistical analysis: Various, but all used some form of regression analysis.</td>
<td rowspan="2">
<table>
<tr><td>8</td><td>15.4</td><td>19.6</td></tr>
</table>

Of the 310 classified as obese or overweight at 1y, 33% were obese or overweight at 8y. 128 classified as obese or overweight at 3y, 53% were obese or overweight at 8y. 196 obese or overweight at 6y, 79% remained obese or overweight at 8y.

Being obese or overweight at 8 was associated with significant odds ratios at younger ages in the table below, all with p<0.001.
<table>
<tr><th>Age (years)</th><th>OR</th><th>95 CI</th></tr>
<tr><td>1</td><td>3.38</td><td>2.50, 4.55</td></tr>
<tr><td>3</td><td>8.45</td><td>5.96, 12.81</td></tr>
<tr><td>6</td><td>51.13</td><td>33.71, 77.52</td></tr>
</table>

Birth weight was positively associated with BMI at 8 (p<0.001).

Association of diet with weight change:
A subset of 340 children, parents completed a food frequency questionnaire and food categories derived via factor analysis. An inverse relationship was found for ‘cereals’ and ‘% energy from total fat’ (p = 0.046 and p = 0.025 respectively) and a positive relationship with the ‘takeaways’ factor (p = 0.025).

Association of physical activity with weight changes:
Playing organised sport at ages 6 and 8 were not significant. Subjective assessment of activity ‘being slightly active’ and ‘active’ at 8 were negatively associated with BMI at 8 years; OR 0.44; 95 CI 0.28, 0.70 (p<0.001) and OR 0.23; 95 CI 0.14, 0.38 (p<0.001) respectively.

Association of other factors with weight changes:
Obesity at 8 was associated with hours per day spent watching TV at age 6; OR 1.53; 95 CI 1.16, 2.02 (p<0.002).

BMI at 8 was predicted by maternal weight and maternal BMI and in a subset of 298 children with paternal data, each obese parent independently increased the risk of obesity at 8 by three times.

Mother being an ex-smoker or never smoked was negatively associated with BMI at 8 years; OR 0.57; 95 CI 0.38, 0.87 (p = 0.009) and OR 0.35; 95 CI
</td>
<td rowspan="2">behaviours particularly in overweight families. Control of excessive weight gain in children beneficial.

Comments: Duration of PA not reported.</td>
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			0.22, 0.53 (p<0.001) respectively.	
			Children from higher income and lower income groups had similar BMI at 3 years but at 6 and 8 years, BMI was higher in lower income families (p = 0.004). Parental income was categorised as lower = below $40,000, or higher = above $40,000. BMI at 6 years was lower in tertiary educated mothers (p = 0.001). Mother's Educational level was categorised as	
			1 not higher than secondary schooling; 2 technical qualification; 3 tertiary qualification.	
Thompson 2004 **Design:** convenience sample from prospective cohort, 2+ **Aim:** To assess the relationship between eating food purchased away from home (FAH) and longitudinal change in BMI *z*-scores among girls, and to assess the longitudinal tracking of eating FAH from childhood to adolescence.	Healthy girls (*n* = 101) between the ages of 8 and 12 years at baseline and 11 and 19 years at follow-up participated in a longitudinal study of growth and development at the Massachusetts Institute of Technology. At baseline the median age was 9 years. 96% of participants had a baseline BMI *z*-score <85th percentile for age and sex. 4% of participants had a BMI ≥85th percentile.	**Year of baseline examination and survey:** Participants originally enrolled in the longitudinal growth and development study in 1990. **Duration of follow-up:** Time varied for all participants, follow-up records were completed a median of 6 years after baseline records were completed **Outcome variables:** Change in BMI z-score, defined as the number of standard deviation units that a person's BMI is from the mean or reference value. *z*-scores were computed with reference to sex and age-specific mean BMI	**Attrition:** 100% – no dropout. **Dietary patterns:** At baseline, 71% of participants ate FAH. At follow-up, this percent increased to 86% and the median number of total FAH occasions had increased from two to three times per week. There was slight FAH tracking from childhood through adolescence. Modest tracking was observed for those who ate quick service food and restaurant food, while no tracking was observed for those who ate at coffee shops. Few participants ate at coffee shops at baseline, but this number increased by 25% at follow-up. **Weight change:** In analysis of variance adjusted for unbalanced cell size, the weekly frequency of consuming quick service food at baseline was positively associated with change in BMI *z*-score ($F = 3.37$, $p \le 0.05$), and this relationship was strengthened after adjusting for baseline BMI *z*-score ($F = 6.49$, $p \le 0.01$). The frequency of eating at coffee shops and in restaurants at baseline was not associated with changes in BMI *z*-score. Duncan's multiple range test showed that participants who ate quick service food twice per week or more at baseline had the greatest means increase in BMI *z*-score at follow-up, and this change was significantly different from that seen in girls who ate quick-service food once or twice a week or not at all. Girls who were eating quick service food twice a week or more were consuming more energy on average than girls who were eating quick-service food once per week or not at all (73 kJ [304 kcal] and 51 kJ [213	**Adjusted for:** Baseline BMI *z*-score. **Author's conclusions:** Consuming quick service food appeared to predispose this sample of girls to increase their relative BMI. **Comments:** It is possible that the tracking observed in this study was as a consequence of increasing age, availability of spending money and/ or self-determination of teens. Most participants were middle to

	The majority of participants (60%) came from families earning at least US$50,000 per year. Most mothers and fathers had at least college level education (72 and 81%, respectively).	values and distributions using the Centers for Disease Control (CDC) and Prevention Growth Chart data. **Self-reported or measured:** Both self-reported and measured. Height and weight measured by health care professionals. Participants kept 7-day dietary records at two points in time, including the place and time for all foods consumed. Foods were classified as quick-service food, coffee-shop food or restaurant food. **Statistical analysis:** Analysis of variance was used to assess the relationship between change in BMI *z*-score and both the frequency of eating FAH and energy derived from eating FAH. The participants' baseline BMI *z*-score was a significant covariate and was controlled for in both	kcal], respectively), but this relationship was not significant **Association of physical activity with weight change:** At baseline 40% of participants considered themselves to be as active as their peers and 51% considered themselves to be more active than their peers PA was not significantly associated with change in BMI *z*-score, therefore was not included in any of the model. **Association of other factors with weight change:** Parental BMI, income and education were not associated with change in BMI *z*-score and so were not included in the models.	upper class White girls who reported being more physically active than their peers, although PA was not a significant covariate, it is possible that PA data were misclassified.

		models. Kappa coefficient was used to assess FAH tracking from childhood through adolescence.		
Phillips 2004 Prospective cohort Aim: To examine the longitudinal relationship of energy-dense snack (EDS) food intake with relative weight status and percentage body fat.	196 non-obese pre-menarcheal girls 8 to 12 years old from the Massachusetts Institute of Technology Growth and Development Study. Ethnicities included 75% white, 14% black and 11% other races.	Year of baseline survey: 1990 and 1993 Outcome variable: BMI z-score, body fat (%BF). Duration of follow-up: 4 years after menarche Self-reported or measured weight: Measured. Statistical analysis: Linear mixed effects modelling	Attrition: 9% Weight changes: None reported without reference to behaviours. Association of diet with weight change: Categories of EDS foods considered were baked goods, ice cream, chips, sugar-sweetened carbonated drinks and sweets, with data collected at annual follow-up visits. No relationship between BMI z score or %BF and total EDS food consumption was observed. Carbonated drinks were the only EDS food that was significantly related to BMI z score over the 10-year study period (p-value for trend <0.001), but it was not related to %BF.	Adjusted for: PA, parental overweight, ethnicity, and dietary variables. Author's conclusion: In initially non-obese girls, overall EDS food consumption does not seem to influence weight status or fatness change over the adolescent period.
Datar 2004 Prospective cohort 2+ **Aim:** To examine the effect of physical education instruction time on BMI change	9751 Kindergartens in the USA. **Baseline BMI or weight:** Boys overweight: 11.6 % Girls overweight: 9.8%	**Year of baseline survey:** 1998 **Duration of follow-up**: 1 year **Outcome variable**: BMI **Self-reported or measured weight:** Measured	**Attrition:** 49% **Weight changes**: Boys, non-Whites (particularly Hispanic children) whose mothers had an educational level of a high school diploma or less, and children from low-income families were significantly more likely to be overweight in kindergarten as well as first grade. **Association of diet with weight change:** No analysis **Association of physical activity with weight change:**	**Adjusted for**: Not reported. **Author's conclusions**: Increasing time spent on physical education programmes in schools, in the form in which they exist, may

<table>
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<td>in elementary school (primary school) from kindergarten to the first grade.</td>
<td></td>
<td>Statistical analysis:
Multivariate linear regression</td>
<td>One additional hour per week of physical education in the first grade compared with the time allowed for physical education in kindergarten reduces BMI among girls who were overweight or at risk for overweight in kindergarten (p > 0.01) but has no significant effect among overweight or at risk for overweight boys (p = 0.02) or among boys (p = 0.31) or girls (p = 0.80) with a normal BMI.</td>
<td>be an effective intervention for combating obesity in the early years, especially among girls.</td>
</tr>
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<td>Growing Up Today study

Berkey, 2000, 2003a, 2003b; Berkey 2005; Field 2003, 2004; Taveras 2005;

Prospective cohort
2+

Aim:
This study examined the role of PA, inactivity and dietary patterns on annual weight changes among preadolescents and adolescents taking growth and development into account.</td>
<td>6149 girls and 4620 boys, aged between 9 and 14 years, from various parts of the USA (50 states who are offspring of Nurses health Study II).

94.7% were White (not Hispanic), 0.9% were Black (not Hispanic), 1.5% were Hispanic, 1.5% were Asian and 1.4% other (including Native American).

Baseline BMI/weight:
At baseline, 23.2% of the boys and 17.4% of the girls were overweight (>85th percentile BMI), while 7.2% of</td>
<td>Year of baseline survey:
1996

Duration of follow-up:
Three 1-year periods.

Outcome variable:
BMI.

Self-reported or measured weight:
Self-reported.

Statistical analysis:
Linear regression.</td>
<td>Attrition:
Girls 32%, boys 42%.

Weight changes:
Girls who were 11 years old at baseline and boys who were 12 years old had the largest mean annual increase in BMI.

The table below shows the mean annual change in BMI (kg/m^2) by age at baseline:

<table>
<tr><th>Age (years)</th><th>Boys</th><th>Girls</th></tr>
<tr><td>9</td><td>0.48</td><td>0.65</td></tr>
<tr><td>10</td><td>0.57</td><td>0.61</td></tr>
<tr><td>11</td><td>0.7</td><td>0.6</td></tr>
<tr><td>12</td><td>0.61</td><td>0.8</td></tr>
<tr><td>13</td><td>0.6</td><td>0.78</td></tr>
<tr><td>14</td><td>0.47</td><td>0.64</td></tr>
</table>

Weight changes:
At 3-year follow-up, changes in BMI were slightly greater among boys than among girls (0.7–0.8 units per year among the boys vs. 0.6–0.7 units per year among the girls (8203 girls and 6715 boys aged between 9 and 14 years of age from Boston USA).

Association of diet with weight change:
Annual BMI increases were higher in girls with higher energy intakes (BMI increased by 0.061 kg/m^2 per 100 kcal (4.2 kJ)/day; p > 0.02).

For both boys and girls a larger rise in energy intake predicted larger BMI increase (girls 0.0059 per increase of 100 kcal [4.2 kJ]/day, boys 0.0082).</td>
<td>Adjusted for:
Race, baseline BMI, annual change in height, menstrual history in girls, Tanner stage and age.

Authors' conclusions:
For both boys and girls, a 1-year increase in BMI was larger in those who reported more time with TV/videos/games during the year between BMI measurements and in those who reported that their energy intakes increased more from one year to the next. Larger annual increases in</td>
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</table>

	the boys and 8.6% of the girls were very lean (<10th percentile BMI).		In boys and girls no significant associations were noted between consumption of energy adjusted dietary fat or fibre and increase in BMI ($p > 0.05$). Overweight children who never ate breakfast lost BMI over 1 year compared with overweight children who ate breakfast nearly every day (boys –0.66 kg/m^2, girls –0.50 kg/m^2). Normal weight children who never ate breakfast gained weight relative to peers who ate breakfast nearly every day (boys 0.21 kg/m^2, girls 0.08 kg/m^2). Over 3 years, normal weight girls who ate breakfast 1–2 days a week gained more weight (+0.072 kg/m^2) than peers who ate breakfast daily. However, overweight boys and girls who skipped breakfast put on less weight than people who had breakfast every day (boys: no breakfasts –0.425 kg/m^2; 3–4 days –0.139; girls who ate breakfasts 1–2 days a week –0.114 and breakfasts on ***3-4*** days per week –0.177. **Association of diet with weight change:** At 3-year follow-up (8203 girls and 6715 boys aged between 9 and 14 years of age from Boston, MA, USA): after controlling for Tanner stage of development, age, height change, activity and inactivity (predictors of BMI), girls showed no relation between intake of fruits, fruit juice or vegetables (alone or combined) and subsequent changes in BMI *z*-score. In boys, intake of fruit and fruit juice was not predictive of changes in BMI. Although vegetables intake was inversely related to changes in BMI *z*-score ($p > 0.05$). However, after adjusting for energy intake, the magnitude of the effect was diminished and no longer significant (Field 2003). At 3-year follow-up (8203 girls and 6715 boys aged between 9 and 14 years of age from Boston, MA, USA): after controlling for Tanner stage of development, age, height change, activity and inactivity, there was no relation between intake of snack foods and subsequent changes in BMI *z*-score among the boys ($\beta = –0.004$), but snack foods had a weak inverse association ($\beta = –0.007$, $p > 0.05$) with weight change among the girls. However, the results were confounded by dieting status, which had a significant positive independent association with BMI change. After controlling for dieting status and whether the mother was overweight, the association between servings per day of snack foods and subsequent changes in BMI *z*-score were not significant in either gender.	BMI were also seen among girls who reported higher energy intakes and less PA during the year between the two BMI measurements. BMI decreased overweight children who never ate breakfast but normal weight children do not. From Berkey 2005; Drinking large amounts of milk may provide excess energy to some children.

			From Berkey 2005; Children who reported higher total milk intake experienced larger weight gains; children who drank more 1% and skim milk had larger weight gains than those who drank smaller amounts of 1% and skim; dietary calcium intake was positively correlated with weight gain; and dietary fat was not. The effects of milk and dietary calcium appear to be explained by energy intake; however skim milk in girls remained marginally significant after adjustment for energy intake. From Taveras 2005; Frequency of family dinner and overweight was explored in the cohort. Subjects were classified as eating dinner with parents ‘never or some days’, ‘most days’ or ‘every day’. Whilst cross-sectional data showed children were less likely to be overweight if they ate dinner most days with their family, this relationship was not apparent over 2 years. **Association of physical activity with weight change:** Annual BMI increases were higher in girls with fewer hours of activity (BMI decreased by 0.284 kg/m^2/h per day of activity; $p > 0.05$) during the year between base line and follow-up. Boys who had marginally less PA (–0.0261 kg/m^2 per hour of activity; $p = 0.094$) showed larger annual BMI increases. The number of gym classes per week was not associated ($p > 0.10$) with change in BMI in boys. **Association of other factors with weight change:** Annual BMI increases were higher in girls with more hours of TV/video/games (BMI increased by 0.372 kg/m^2 per hour per day; $p > 0.001$) during the year between base line and follow up. Boys who spent more time with TV/videos/games (0.384 kg/m^2 per hour per day; $p > 0.0001$) showed larger annual BMI increases. Over 2 years, boys had higher means hours of TV/video/games, gym class participation that increased more from the first to the second year, and energy intake that increased more from the first to the second year predicted larger increases in BMI. Boys with higher METs (a way of measuring PA intensity) during the year between the two BMIs had marginally smaller ($p = 0.6$) increases in BMI. **Age:**	

			Among boys <12 years old, those who did more PA in the year between the BMI measurements had smaller annual increases in BMI (–0.0746 ± 0.0212).	
FRAMINGHAM CHILDREN'S COHORT Moore 2003 Proctor 2003 Moore 1995 Prospective cohort Aim: To examine the relationship between physical activity and TV viewing on body fat change during childhood	106 3-5-year olds from the Framingham Children's Study. These are from families who were third or fourth generation from the original Framingham Study Cohort.	Year of baseline survey: 1987 Outcome variable: BMI Duration of follow-up: 8+ years. Self-reported or measured weight: Measured. Statistical analysis: Various, but all used some form of regression analysis.	Attrition: 3% Weight changes: None reported without reference to behaviours. Association of diet with weight change: Children with the highest levels of TV viewing and high fat diets (>34% cals from fat) gained more body fat than children watching least TV and a lower-fat diet (<34% fat cals) gained less body fat by 11 years; mean sum of 5 skinfolds 99mm vs 69mm (data presented graphically). Association of physical activity with weight changes: Subjects were examined annually. Caltrac motion sensors were used to asses physical activity levels. Children were categorised as having low, medium or high activity levels based on average number of counts per hour for each period of recording. These were then averaged over the 8 years of the study. Children in the highest tertile for daily PA, had consistently smaller gains in BMI, triceps and sum of 5 triceps throughout childhood. By 11 years, sum of 5 skinfolds was 95.1mm, 94.5mm and 74.1mm for the low, medium and high tertiles respectively (p-value for trend = 0.045). This relationship was evident for both sexes. Children with the lowest levels of PA and highest levels of TV viewing gained nearly 40 mm of body fat than children with highest levels of PA and least TV by 11 years (data presented graphically). Association of other factors with weight changes: Questionnaires in conjunction with the Caltracs were used to estimate hours of TV viewing and video games per day. TV viewing was divided into tertiles of hours per day: <1.75h, 1.75 to <3.0h, >3.0h. At 11 years, those who watched 3.0h or more per day had a mean sum of 5 skinfolds of 106.2mm compared with 87.6mm for those watching 1.75 to <3.0h, and 76.5mm for those watching least (p = 0.007; p-value for trend = 0.028).	Adjusted for: sex, exact age and baseline BMI, total energy intake, % fat calories, mean PA level, parents age and education. Author's conclusion: Children who were in the highest level of activity showed less acquisition of body fat, whilst those watching most TV showed the greatest gains in body fat.
Bogaert 2003 Prospective cohort 2+	59 Australian children, aged between 6 and 9 years (mean age	**Year of baseline survey:** Not reported. **Duration of follow-up**:	**Attrition:** 31% **Weight changes:** No significant differences were found for initial, height, BMI percentile and	**Adjusted for:** Not reported. **Author's conclusions:**

Aim: To identify whether measures of energy intake and expenditure predict excessive weight gain over time in children.	8.6 ± 0.2 years) **Baseline BMI or weight:** Not reported.	12 months. **Outcome variable**: Weight (kg), BMI **Self-reported or measured weight:** Measured. **Statistical analysis**: Unpaired *t* test, Pearson's product moment correlation and Spearman's rank order correlation.	BMI *z*-scores over the 12 months. The boys BMI *z*-score was 0.3 ± 0.1 and the girls score was 0.5 ± 0.3. Percentage body fat was 18.4 ± 1.2 for boys and 25.8 ± 1.1 for girls, and percentage lean body mass was 81.6 ± 1.2 for boys and 74.2 ± 1.1 for girls. Girls had a significantly lower mean lean body mass ($p > 0.0001$) and a significantly greater mean fat mass than boys ($p > 0.0001$) after 12 months. **Association of diet with weight change:** No significant correlations were shown between BMI over 12 months for any dietary variable (% energy as protein, carbohydrate, fat, saturated fatty acids, monosaturated fatty acids and polyunsaturated fatty acids). **Association of physical activity with weight change:** No significant correlations were shown between change in BMI over 12 months and any measures of energy expenditure, including hours of television viewing or percent time spent in low, moderate or high intensity activity. A significant correlation was found both between mothers and daughters in percent time spent in moderate to high activity ($r = 0.44$, $p = 0.03$), and also between fathers and children for percent time spent in low activity ($r = 0.43$, $p = 0.005$), which suggests that parental activity levels can significantly affect their child's activity levels.	The study was unable to identify environmental predictors that indicate propensity to weight gain over time in this cohort of children, but has extended the evidence on lifestyle-influenced predictors that do. An overall lack of vigorous activity and correlations between parental and child activity and inactivity have been identified.
Kaur 2003 Prospective cohort 2+ **Aim:** To assess the effect of TV viewing on subsequent change in BMI percentiles in adolescence.	12–17 year olds, $n = 2223$, 52% male, 68% White, California, contacted by random-digit dialled computer-assisted telephone interviewing method as part of California Tobacco	**Year of baseline survey:** 1993 **Duration of follow-up**: 3 years **Outcome variable**: Change in age-specific and sex-specific BMI percentiles. **Self-reported or measured weight:** Self-report.	**Attrition:** 65.8% of sample had data for both time points. **Weight changes:** BMI at follow-up (mean [SD]): 22.57 (3.57); BMI% at follow-up (mean [SD]): 53.83 (26.92). **Association of diet with weight change:** **Association of physical activity with weight change:** Hours of TV viewed at baseline (mean/SD): 2.85 (1.98); model of TV at baseline and BMI% at follow-up explained 50% variation in follow-up BMI%; squared partial correlation coefficients were 0.495 for baseline BMI%, 0.008 for baseline TV, 0.003 for ethnicity; therefore nearly 50% variation in follow-	Adjusted for ethnicity and baseline BMI%. **Author's conclusions:** TV viewing leads to increase in BMI percentiles and overweight.

California Teen Longitudinal Survey of adolescents 12–17 years	Surveys. **Baseline BMI (kg/m^2), mean (SD):** 21.00 (3.52) BMI% 55.92 (26.78)	**Statistical analysis**: Multiple regression modelling and logistic regression.	up BMI% explained by baseline BMI%, 1% by TV, 0.3% by ethnicity. Watching >2 hours TV was related to higher odds of being overweight at follow-up among adolescents at normal weight at baseline (OR 1.9; 95% CI 1.1, 3.5) and among adolescents overweight at baseline (OR 2.8; 95% CI 1.3, 6.3). 48% new-onset overweight among adolescents not overweight at baseline was attributable to watching >2 hours TV per day. For each additional hour TV at baseline the average follow-up BMI% increased by 0.5, controlling for ethnicity and baseline BMI%.	
Ambrosius 2001 Prospective cohort 2+ **Aim:** To determine the rate of change in adiposity over time, making comparisons between racial and gender groups.	Healthy children aged 5–20 years (mean 9.5–10.5 years at baseline) recruited from schools in Indianapolis, USA. Schools were chosen to represent a range of SES. Total *n* = 773; 229 White and 157 Black boys, 213 White and 174 Black girls. Over the course of the study, 250 children (102 Black and 148 White) moved from the area, 114 (54 Black and 60 White) dropped out of the study, and 129 (36	**Year of baseline survey:** Study began 1985 and measurements ended in 1999. **Duration of follow-up**: 6 monthly visits; range 2 (6 months) to 26 visits (12.5 years). **Outcome variable**: Change in BMI and subscapular and triceps skinfold thicknesses. **Self-reported or measured weight:** Measured. **Statistical analysis**: Analysis of covariance was used to test for race and sex differences among the subjects at baseline, after adjusting for age.	**Attrition:** Approximately 39%. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** **BMI etc changes (units per year):** White (W), Black (B) **BMI (kg/m^2):** W boys (*n* = 229) 0.78; B boys (*n* = 157) 0.97 W girls (*n* = 213) 0.76; B girls (*n* = 174) 0.96 **Subscapular skinfold thickness (mm):** W boys 0.64; B boys 0.74 W girls 0.90; B girls 1.00 **Triceps skinfold thickness (mm):** W boys 0.12; B boys 0.13 W girls 0.70; B girls 0.71 **Waist-to-hip ratio:** W boys –0.0047; B boys 0.0006 W girls –0.0045; B girls 0.0008	Age. **Author's conclusions:** Body fat increases at a faster rate in Black children than in White children. It appears that racial and gender differences in prevalence of obesity originates in childhood.

	Black and 93 white) were lost to follow-up. **Exclusion criteria:** History of renal or cardiac disease, hypertension, diabetes mellitus. **Baseline BMI etc., mean (SD):** White (W) Black (B) **BMI (kg/m^2):** W boys 18.3 (4.7), B boys 20.0 (5.3) W girls 17.8 (3.6), B girls 20.3 (5.8) **Subscapular skinfold thickness (mm):** W boys 8.6 (7.7), B boys 11.0 (8.5) W girls 9.2 (6.2), B girls 13.2 (9.0) **Triceps skinfold thickness (mm):**	A random coefficient model was used for the main analysis.	 **Summary:** The rate at which BMI increased in Black children was significantly greater than in the White children (*p* > 0.0001) There were no gender differences in the rate of increase of BMI. Results also presented for other measures of fatness. Supplementary analysis was carried out to examine the rates of change with age and educational attainment.	

	W boys 12.7 (6.8), B boys 13.8 (8.5) W girls 13.9 (5.7), B girls 15.6 (8.1) **Waist-to-hip ratio:** W boys 0.84 (0.07), B boys 0.81 (0.06) W girls 0.76 (0.06), B girls 0.77 (0.07**)**			
O'Loughlin 2000 Prospective cohort 2+ **Aim:** To identify 1- and 2-year predictors of excess weight gain amongst preadolescents .	2318 children at 1 year follow-up aged 9– 12 years and 633 children aged 9– 11 years with 2 years follow-up in 16 elementary schools located in multiethnic low-income neighbourhoods in Montreal, Canada; high ethnic diversity with 80% parents born outside Canada and 80% fathers unemployed **Baseline BMI:** 18.0–	**Year of baseline survey:** 1993–97 **Duration of follow-up**: 2 years **Outcome variable**: Change in BMI. **Self-reported or measured weight:** Measured. **Statistical analysis**: Multiple logistic regression analyses (dependent variable was whether or not the subject was in the highest age and gender specific decile of change in BMI.	**Attrition:** 57.7% available data at 1 year and 60.2% at 2 years **Weight changes:** Students in top decile of change in BMI increased 2–2.5 BMI units over 1 year compared with 1 BMI unit or less among those at the 50th percentile, over 2 years students in the top decile increased 3–4 units compared with 1–2 BMI units among those at the 50th percentile. **Association of diet with weight change:** **Association of physical activity with weight change:** One year predictors of higher decile of change in BMI included no sports outside school (OR 1.90; 95% CI 1.18, 3.06) in girls. Two-year predictors included no sports outside school (OR 2.14; 95% CI 0.96, 4.77) and least active (OR 2.18; 95% CI 1.01, 4.71) in boys. One year predictors of higher decile of change in BMI included BMI of 90th percentile or more (OR 2.66; 95% CI 1.80, 1.34) in boys and BMI of 90th percentile or more (OR 2.34; 95% CI 1.46, 3.76), and playing video games everyday (OR 2.48; 95% CI 1.04, 5.92) in girls. Two-year predictors included baseline BMI of 90th percentile or more (OR 3.26; 95% CI 1.52, 7.01), and only BMI of 90th percentile or more (OR 2.22; 95% CI 1.02, 4.81) in girls.	Cohort is comparison schools (control schools) in a heart health programme; children lost to follow-up lived in less advantaged families of non-Canadian origin. **Adjusted for:** Age at baseline, grade, year of cohort, school, dependence between observations of same subject (*n* = 549) in 1-year follow-up; **Author's conclusions:**

	20.0 kg/m^2.		**Summary of results:** Baseline BMI was only consistent independent predictor of excess weight gain in all four multivariate models; there were no strong or consistent pattern of associations in either boys or girls for family origin, diet indicators, school sports team or TV viewing	Results suggest need for interventions to promote PA in children.
Spiegelaere 1998 Cohort 2+ **Aim:** To determine whether social inequalities in obese adolescents can be partly explained by differences in the evolution of body mass during the critical period of adiposity rebound.	675 children born 1986–90 attending preventive medical services in Brussels, only Belgium children (immigrant children excluded). **Baseline BMI:** Prevalence of overweight (BMI >95th centile distribution for age and sex) 4.6%.	**Year of baseline survey:** Not reported. **Duration of follow-up**: 3 years (analysed retrospectively). **Outcome variable**: BMI change. **Self-reported or measured weight:** Measured . **Statistical analysis:** χ^2 and Kruskal–Wallis test.	**Attrition:** n/a, convenience sample **Weight changes:** Adiposity rebound (BMI at age 5 years greater than BMI at age 3 years) occurred in 30.4% of the children and did not differ between social groups; 205 of 675 had early adiposity rebound and mean BMI increased by 0.76 (0.82) kg/m^2. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change: Adiposity Rebound** After controlling for BMI at baseline, relationship between social status and presence of an early rebound remained non-significant; In lower socio-economic groups a greater proportion of children had an important increase in BMI between ages 3–5 years (>1.6 kg/m^2, above the 9th decile <0.05) 18.3% lower socio-economic group (active manual workers and not working), 7.1% intermediate social group (active self-employed and technicians) and 7.8% high socio-economic group (upper management and professionals).	**Adjusted for:** Early rebound adjusted for BMI at baseline. **Author's conclusions:** Adiposity rebound before age 5 years was inversely related to body mass at age 3 years and was independent of social status.
French 1996 Prospective cohort 2+ **Aim:** To estimate the change in BMI over 3 years in a cohort of adolescents, dependent on	All students aged 12 to 15 years (UK school years 8 to 10) at baseline in schools in a suburb of Minnesota. Total *n* = 1278 at 3 years; 656	**Year of baseline survey:** Unclear. **Duration of follow-up**: 3 years. **Outcome variable**: BMI. **Self-reported or measured weight:**	**Attrition:** Approximately 16%. **Weight changes:** Not reported separately. *Note:* all associations stated below were significant but modest in magnitude. **Association of diet with weight change:** No analysis.	**Adjusted for**: Fathers occupation, year at school, pubertal status and BMI at baseline. **Author's conclusions:** Self-esteem specific to

baseline self-esteem. Data for this study were collected as part of a longitudinal study on the development of eating disorders.	females and 622 males which represented approximately 84% of children invited to take part in the study. 89% White, 4% other or mixed, 3% Asian American. Approximately 48% fathers and 33% mothers held executive, administrative or professional occupations. **Baseline BMI (kg/m^2), mean (SD):** Males 20.1 (3.7); females 20.5 (3.6) 20.6 % of males and 17.6 % of females were overweight.	Measured. **Self esteem:** The Harter Self-Perception Profile for Adolescents. Pubertal status was assessed. **Statistical analysis**: Prospective relationships between self-esteem at baseline and BMI 3 years later were examined using partial correlations. In addition, a series of logistic regressions were run using overweight status as the independent variable and self-esteem subscales as independent variables.	**Association of physical activity with weight change:** No analysis. **Association of other factors with weight change: self-esteem** Partial correlations between baseline **self-esteem** and BMI 3 years (Table 3 in paper). In females, low physical appearance and low social acceptance self-esteem at baseline were associated with higher BMI 3 years later. In males, baseline self-esteem was unrelated to BMI 3 years later. Analyses examining relationships between baseline self-esteem and overweight status 3 years later showed high close friendship self-esteem in females and high physical appearance self-esteem in males were associated with decreased odds of overweight at 3 year follow-up.	physical appearance is modestly associated with BMI.
Klesges 1995 Prospective cohort 2+ **Aim:** To determine the dietary, PA,	Parents of 146 (110 boys and 93 girls) aged 3–5 years (mean 4.4 years boys, 4.3 years girls) recruited to participate in longitudinal	**Year of baseline survey:** Not reported. **Duration of follow-up**: 3 years (analysed change over 2 years). **Outcome variable**:	**Attrition:** 35 of 203 families at one year and 55 of 203 families at 2 years. **Weight changes:** Adjusted BMI changes over 2 years: Both parents normal weight: boys –0.305, girls –0.230 Father overweight: boys –0.436, girls 0.400 Mother overweight: boys –0.262, girls –0.532 Both parents overweight: boys 0.670, girls –0.230	Participants not told study was to assess predictors of body fat. **Adjusted for:** BMI adjusted for family risk

family history and demographic predictors of relative weight change in a cohort of children.	evaluation of cardiovascular risk development in young children in Memphis, TN, USA. Children had to be natural biological offspring of parents, no physical condition that could effect relative weight, dietary intake or PA. Parents who were married and had no cardiovascular disease and were staying in the area for the following year. Only one child per family. Obese children were over-sampled **Baseline BMI (kg/m^2), mean (SD):** 16.1 (1.4) boys, 16.1 (1.2) girls; 40% overweight (relative weight greater than 75th percentile);	BMI change. **Self-reported or measured weight:** Measured. **Statistical analysis**: Multiple regression analysis (hierarchical and stepwise-selected variables); final regression model resulted in significant equation $F(13, 119) = 2.71$, $p > 0.0022$). BMI, sex, age, family risk and sex by family risk interactions = 9.8% variance. Baseline percentage energy as fat, baseline aerobic activity, change (year 2–3) in percentage energy as fat, change (year 2–3) in leisure activity = 13.1% variance.	BMI increased in girls with fathers overweight and boys with both parents overweight. **Association of diet with weight change:** Higher baseline percentages of energy as fat were associated with greater increases in BMI (0.168 kg/m^2 per 5%) and recent increases (year 2–3) in percentage of intake as fat (0.201 kg/m^2 per 5% change). Neither baseline total energy nor change in total energy increased variance in change in body mass. **Association of physical activity with weight change:** Higher baseline aerobic activity and increased leisure activity from year 2 to 3 were associated with BMI decreases. **Association of other factors with weight change: parental overweight** Boys with both parents overweight had increases in children's BMI (0.67 kg/m^2) and for girls those with just a father overweight showed BMI gains over 2 years (0.40 kg/m^2).	(number parent overweight) baseline BMI, child sex and age and interaction between child sex and family risk. **Author's conclusions:** Modifiable (dietary intake and PA) and non-modifiable factors (age, family history for overweight) were associated with change in BMI in preschool children with largely modifiable factors appearing to be slightly more important.

	45% families had both parents normal weight, 27% father overweight, 17% mother overweight, 11% both parents overweight.			
Robinson 1993 Prospective cohort 2+ **Aim:** To longitudinally examine the relationships between hours of TV viewing and adiposity in female adolescents.	279 adolescent girls, participating in the no-intervention arm of a study about eating disorders. From four schools in California. Mean age 12.37 (SD 0.73) years. 42.7% White, 23.3% Hispanic/Latino. **Baseline BMI (kg/m^2), mean (SD):** 20.33 (3.89)	**Year of baseline survey:** 1989 **Duration of follow-up**: 2 years. **Self-reported or measured weight:** Measured. **Statistical analysis**: All available follow-up data were used to fit subject-specific least-squares regression lines for changes in Sexual Maturity Index (SMI)-adjusted BMI, and SMI-adjusted triceps skinfold thickness (where height and weight were measured, not self-reported). The outcome variable was the slope of these fitted lines. Univariate relations were tested using Spearman	**Attrition:** Unclear. The sample used in the longitudinal analysis was drawn from a total of 536 students who were initially randomised to the no-intervention control group as part of the overall study – suggests attrition of 48%. **Weight changes:** Not reported. **Association of diet with weight change:** No analysis. **Association of physical activity with weight changes:** No analysis. **Association of other factors with weight changes:** Hours of after-school TV viewing did not longitudinally predict change in SMI-adjusted BMI (univariate Spearman *r* = 0.03, *p* = 0.62; multivariate regression co-efficient estimate = 0.05, *p* = 0.82). Hours of after-school TV viewing did not longitudinally predict change in SMI-adjusted triceps skinfold thickness (univariate Spearman *r* = 0.03, p = 0.54; multivariate regression co-efficient estimate = –0.19, *p* = 0.67). Reported hours of after-school TV viewing did correlate negatively with PA levels cross-sectionally (Spearman *r* = –0.086, *p* = 0.026) but explained only <1% of the variance. (Regression coefficient estimate = –1.281, *p* = 0.043.)	**Adjusted for:** In multivariate analyses, adjusted for age, race, parent education and parent fatness. TV viewing was measured by asking subjects how much time they spent in 13 different activities after school. While the validity of this method may be questioned, it had good test-retest reliability – over 24 months, *r* (Spearman) = 0. 37, *p* > 0.0001. **Author's conclusions:**

		correlation. Multivariate relations tested using multivariate logistic regression.		TV viewing was not associated with changes in adiposity, factors such as the content of and responses to viewing, and the family/peer environment may be more important than total viewing hours.
McConahy 2004 Cross-sectional cohort Aim: To evaluate the relationship of dietary behaviours and total energy intake.	5447 children aged 2-5 years who participated in the Continuing Survey of Food Intakes by Individuals.	Year of baseline survey: 1994-1996 Outcome variable: Body weight Duration of follow-up: 2+ years. Self-reported or measured weight: Parental self-report. Statistical analysis: Multiple linear regression.	Attrition: 0% Weight changes: None reported without reference to behaviours. Association of diet with weight change: Portion sizes (mean gramme quantities consumed at an eating occasion) were determined for the top 10 most commonly consumed foods. Z-scores were calculated for quantities consumed by children so data could be entered into the regression analyses. Diet was assessed using two non-consecutive 24h recalls. Body weight, food portion size, number of eating occasions and number of foods accounted for 38% of the variance in 2-3-year-olds and 39% in 4-5-year-olds. Portion size as a single predictor explained 17% of the variance in 2-3-year-olds and 19% in 4-5-year-olds.	Adjusted for: Body weight. Author's conclusion: Feeding recommendations should highlight age appropriate portion sizes and give guidance on frequency of eating and number of foods consumed.

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EVIDENCE TABLE 2: MAINTAINING ENERGY BALANCE IN ADULTS

2.1 Summary: evidence from reviews

2.1.1 Dietary factors

With regard to the evidence from reviews, Williamson (1996) found that of the eight studies, two of found that total energy intake was positively associated with weight gain (Rissanen et al. 1991; Klesges et al. 1992). In both of these studies a positive association was found only in women. In Klesges et al. (1992) study a higher energy intake by women was directly related to increased weight gain while in men a higher energy intake was associated with decreased weight gain. In Rissanen et al. (1991) total energy intake had a direct association with subsequent weight gain in women only. The significant associations between weight gain and dietary fat intake were also inconsistent. Kant et al. (1995) found that the percentage of total energy intake from fat was positively related to weight gain in men and the association between percentage of energy intake from fat and weight gain was significantly inverse for women. Total fat intake was positively associated with weight gain in women but not men in one study and vice versa in another study.

2.1.2 Physical activity

With regard to the evidence from reviews, Williamson (1996) found three prospective studies that reported results for prospective analyses. Klesges et al. (1992) and Owens et al. (1992) found that women with higher levels of PA gained less weight. Klesges et al. (1992) found that PA was positively associated with weight gain in men whereas another study found no association between weight gain and PA.

Saris (2003) concluded that from13 cohorts reporting PA level (PAL) and weight change, 11 showed an inverse relation between PAL and increase in BMI, body fat, and weight or percent overweight/obese.

2.1.3 Other behavioural, psychological, social and environmental factors

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2.2 Summary: evidence from individual studies

2.2.1 Menopause (all women premenopausal at baseline)
Five cohorts examined weight change in relation to the menopause in women from the USA, UK, Chile and Japan. MacDonald (2003) analysed 1064 White women in the UK who were premenopausal at baseline and followed for 6 years and found that mean weight increased and was influenced more by reduced energy expenditure than increased energy intake.

Nagata (2002) analysed a cohort of Japanese women for 6 years and found that nutrient intakes were not significantly associated with difference in weight change between premenopausal and postmenopausal women. Exercise (METs [hours per week]) was not significantly associated with difference in weight change between premenopausal and postmenopausal women. Higher number of births was significantly associated with weight gain in premenopausal women, and early age at menarche was significantly associated with weight gain in postmenopausal women; hormone replacement therapy (HRT) use, smoking status, alcohol consumption were not significantly associated with difference in weight change between premenopausal and postmenopausal women.

Blumel (2001) analysed 271 Chilean women for 5 years and found that weight gain was similar in those who did or did not use HRT (non users 4.3 ± 4.8; users 3.5 ± 3.7 kg; ex-users, 3.4 ± 5.8 kg).

The Healthy Women's Study followed 500 US women for 3–4 years and found there were no significant differences in weight gain of women who remained pre menopausal and those who had a natural menopause (2.07 vs. 1.35 kg). Women who took HRT and women who stopped smoking during the menopause had significantly greater weight gain.

The Massachusetts Women's Health study followed 400 women for 3 years and found that menopause transition was not consistently associated with increased weight, reduced exercise and increased alcohol consumption were more strongly related to weight gain than menopause transition.

2.2.2 Pregnancy
Seven cohorts examined weight change and pregnancy. Williamson (1994) followed-up 2547 white women aged 25-45 years over 12 years, from the first National Health and Nutrition Examination Survey. The SPAWN study examined long-term weight development after pregnancy of 1423 women from Stockholm Sweden and had a 15-year follow-up. Olsen's (2003) study consisted of 622 healthy adult women who gave birth to live singleton infants from New York State, USA. Rosenberg (2003) followed a cohort of 1200 African American women for 4 years and the CARDIA study followed more than 5000 African American and White women for 4 years. More than 10,000 women were followed for 10 years as part of the NHANES I and NHEFS (Wolfe 1997) to examine the effect of parity on weight and a small study of women who breast-fed examined the effect of having more than one child on subsequent weight over an 18-month period (Sowers 1998).

Results of the studies show that those who gained more weight or ate more during pregnancy were more likely to retain weight gain after pregnancy.

Williamson (1994) examined 2547 white women aged 25-45 years from the first National Health and Nutrition Examination Survey. The risk of becoming overweight was increased by 60-110% in women having live births over the 12-year study period. Over 12 years average weight gain whilst having children was modest in US white women, but for some women the risks of major weight gain and becoming overweight are increased in association with childbearing.

The SPAWN study followed for 15 years 1400 women who had given birth and found women that started to eat more irregularly retained more weight at 1-year postpartum and women that started to exercise less frequently after their pregnancies retained more weight 1-year postpartum. Most important risk factor identified for sustained weight gain/retention 1 year after delivery was weight increase during pregnancy. No difference between women who became overweight and those who remained normal weight regarding total number of children, number of pregnancies before and after index pregnancy, age at index pregnancy, age at delivery of first child. Women who became overweight had lower lactation scores ($p > 0.05$) ; relatively more subjects of the group that became overweight stopped smoking during pregnancy ($p > 0.01$).

Olson (2003) followed 600 mainly White women in New York for 2 years and concluded that women who reported eating much more food in pregnancy were 2.35 times more likely than women who ate a little more to gain excessive weight (women were asked how the amount of food they ate had changed compared with when they were not pregnant, response categories were 'a lot less food', 'a little less food', 'a little more food' and 'a lot more food'). Less PA (OR 1.68; 95% CI 1.1, 2.6) was significantly related to excessive gestational weight gain. Family income of less than 185% of the federal poverty line (OR 2.59; 95% CI 1.6, 4.2) was significantly related to excessive gestational weight gain. Income was not as important an influence on gestational weight gain among women who reported that they increased their food intake (OR 0.33).

Rosenberg 2003 followed 1200 African American women for 4 years and found that women who had a child during follow-up gained more weight than women who remained nulliparous, and those who had a first child gained more than those who had a second or later child. Weight gain associated with childbearing increased with increasing baseline BMI and was appreciable among heavier women.

The ongoing CARDIA study in 5000 African American and White women found primiparous within both race groups gained 2 or 3 kg more weight during the 5-year period than did nulliparous women. Multipara did not differ from nulliparous in adiposity change in either race group. At each level of parity, Black women demonstrated greater adverse changes in adiposity than did White women.

Analysis of parity amongst women in the NHANES I and NHEFS (Wolfe 2004) showed weight gain from baseline to 10 year follow-up averaged 4.4 kg for White women and 5.5 kg for African American women.

Among White women, after adjusting for baseline parity and other socio-demographic variables, the weight gain for non-employed married metropolitan women averaged 4.2 kg for those with no change in parity, compared with 4.7 kg for those with a parity increase of one child and 7.4 kg for those with a parity increase of two or more children. Among African American women, adjusted for the same variables, weight gain for those with no change in parity averaged 4.9 kg, compared with 7.2 kg for those with a parity increase of one or more.

The probability of substantial weight gain (more than 11.4 kg) also rose with parity increase. White women with a parity increase of two or more were also twice as likely to experience substantial weight gain as those with no change in parity. However, the probability increased only slightly for those with a parity increase of just one. Among African American women, those with an increase in parity were about five times as likely to experience substantial weight gain as those with no parity increase.

Sowers (2004) evaluated 45 women who breast-fed and at 18-month follow-up the average weight losses in the postpartum period were 4.7 kg for cases and 4.4 kg for controls, which was not significantly different.

There was no statistically significant difference between the weight retention patterns of all the women. The average weight retention curve for the cases and controls (further parity vs. one parity) had similar shapes, initially they declined and then began to plateau at about 8–10 months postpartum.

Among the cases, post pregnancy weight following the baseline pregnancy was compared with post pregnancy weight following the subsequent pregnancy. On average, cases weighed 1.3 kg more after the subsequent pregnancy than they weighed following the baseline pregnancy.

2.2.3 Marriage

Two cohorts (Kahn 1990; Rauschenbach 1995) assessed weight change and change in marital status. Rauschenbach (1995) found that women who entered marriage had greater weight change than women who remained married, for men there were no statistically significant relationships between marital change and weight change. In the model to predict weight change none of the interactions were significant; in the model to predict weight gain none of the interactions were significant for women but for men the interaction of education with becoming unmarried was significant ($p = 0.024$) and associated with greater weight gain in more educated that become unmarried.

Kahn et al. (1990) evaluated the effect of marriage on weight in data from the NHANES I and NHEFS. The mean 10-year change in BMI was similar for the men who were not consistently married and for the men who were married at both baseline and follow-up (0.90 vs. 0.80, respectively).

The non-consistently married men had a significantly wider distribution of this weight-change variable. Men who became married during the 10-year interval showed a trend towards a greater gain in BMI when compared with men who were consistently married. Those men whose marriage ended appeared to experience a relative loss in BMI.

The incidence of major weight gain was generally greater for the men who were not consistently married. The incidence of major weight loss was also generally greater for the men who were not consistently married. The mid-range weight outcome was generally more common among men who were consistently married.

2.2.4 Smoking

Six cohorts assessed smoking cessation and association with weight change.

Williamson (1991) examined data from the NHANES I study and found those who quit smoking for more than 1 year experienced a greater mean weight gain and were more likely to experience major weight gain than continuing smokers. Significant weight gain occurs in a minority of those who quit. By the end of the study (10 years), however, the mean body weight of those who had quit increased only to that of those who had never smoked.

Burke (2000) followed 1930 Mexican American (MA) and non-Hispanic Whites (NHW) for 9 years and found the estimated risk of becoming overweight or obese attributable to smoking cessation was only 7.4% in MA and 3.1% in NHW. The Israeli CORDIS study followed 3816 male factory workers and showed that smoking cessation is associated with weight gain which is still apparent 6-years post-cessation. Burnette (1998) analysed smoking cessation within the Healthy Women's study of 500 US women and found that smoking cessation in perimenopausal to postmenopausal women is associated with greater weight gain for up to 2 years.

Kawachi (1996) analysed women who gave up smoking in the Nurses Health Study of 121,700 women for 2 years and found that weight gain was minimised if smoking cessation was accompanied with moderate increase in levels of PA.

Swan (1995) analysed men over 16 years from the US Twin Registry and found quitters were more likely to experience weight gain of 2.3 kg or more, and less likely to experience weight loss, than continuing smokers and non-smokers. Amongst quitters, super-gainers were younger, of lower SES, and differed on a number of health habits before quitting.

2.2.5 Occupation- and work-based cohorts

Eleven cohorts assessed associations with weight change amongst adults in various occupations and work settings.

Dietary factors:

Bazanno (2005) followed 17,881 US male physicians aged 40 to 82, free from disease for 13 years. Based on self-reported data, they found those men consuming ≥1 serving per day weighed less than those never or rarely consuming cereals. The trends at 8 and at 13 years were both significant (p-value for trend = 0.001). Men who ate ≥1 serving per day were 22% and 12% less likely to become overweight at 8 and 13 years respectively, compared with men who never/rarely ate cereals; relative risk 0.78; (95 CI 0.67, 0.91) and 0.88; (95 CI 0.76,1.00) respectively.

During the 12-year follow-up in the Nurses Health study (He 2004), participants tended to gain weight with age, but those with the largest increase in fruit and vegetables had a 24% lower risk of becoming obese compared with those who had the largest decrease in intake. Similar results were observed for changes of fruit and vegetables and separately.

Schulze (2004) followed 51,603 young nurses in the USA and reported a higher intake of sugar-sweetened beverages was associated with a greater magnitude of weight gain, attributed to excessive energy from the drinks and large amounts of rapidly absorbable sugars found in the drinks.

The Health Professionals Follow-up Study (Koh Banerjee 2003) followed 16,587 health professionals in the USA for 9 years and concluded that waist gain may be modulated by changes in *trans* fat and fibre consumption, smoking cessation and PA.

Gerace (1996) reported that fire fighters who ate faster at the station than else where gained 9.9 lb (4.49 kg) by follow-up (1991) compared with those who said their pace did not differ by location, who increased 6.8 lb (3.12 kg) by 1991, while those who did not nibble increased by 6.9 lb ($p > 0.05$).

Men who reported consuming a good diet in the Whitehall II study (four of total of four healthy aspects of diet) had OR 0.73 (95% CI 0.64, 0.84) and for women OR 0.83 (95% CI 0.68, 1.02) (Martikainen 1999).

Physical activity: Gerace (1996) reported that fire fighters self-reported PA levels at baseline were not associated with change in weight ($p > 0.05$). Likewise, the amount of energy in PA reported at baseline was not associated with weight change ($p > 0.05$). Subjects who reported engaging in at least one recreational PA three or more times per week gained 7.2 lb (3.26 kg) compared with less active fire fighters who gained 9.5 lb (4.30 kg) ($p > 0.05$).

Men in the Whitehall II study (Martikainen 1999) who reported moderate and vigorous PA were less likely to experience an increase in BMI (age-adjusted OR of having a gain in BMI >3 kg/m^2 compared with having a BMI gain of 0–3 kg/m^2).

UK men who became non-employed were significantly more likely to be inactive compared with men who remained employed (39.4 vs. 36.7%; 95% CI of the difference 0.1, 5.7) (Morris 1992).

In the Nurses Health Study II, vigorous PA was protective against weight gain. Women who engaged in ≥5 hours per week of vigorous activity gained approximately 0.5 kg less than their inactive peers between 1989 and 1995. Total hours of activity per week (including walking) was not associated with weight change. Physical inactivity was associated with weight change. For each 10 hours per week a women spent sitting at home or at work, she gained approximately 0.11 kg more than her less inactive peers.

Other behavioural, psychological, social, environmental factors: In a 3-year study of 119 Japanese factory workers, Yamada (2001) found that statistically, no significant changes were found for either the entire 8-hour shift group or the age subgroups during 1996–99. Authors concluded 12-hour shift might be associated with unhealthy weight gain in some clean room workers.

In the Whitehall II study of 5000 UK civil servants over 5–6 years (Martikainen 1999) it was found that employment grade was strongly related to BMI gain from age 25 years to phase 3 (about 25 years), the lower the grade the larger the gain in BMI, and adjustment for health behaviours (smoking, alcohol, etc.) reduced the grade differences in BMI gain by about 20%.

Nakamura (1998) studied non-management White collar Japanese men and found that working overtime was associated with increases in BMI and waist-circumference over 3 years (only explains 5% variance) although the associations were weak; eating habits of those working overtime may reflect an intervening effect on anthropometric changes.

Gerace (1996) reported that fire fighters aged 20–29 years gained the most weight over 7 years (11.3 lb [5.12 kg]). Subjects who were married or living as married gained 7 lb (3.17 kg) compared with those who were never married, divorced, separated, or widowed who gained 11.7 lb (5.30 kg) ($p > 0.001$). Black non-Hispanics gained 15.7 lb (7.12 kg) compared with White Hispanics who gained 8.9 lb (4.03 kg) and White non-Hispanics who gained 6.7 lb (3.03 kg) ($p > 0.001$). Fire fighters who smoked at baseline and reported being ex-smokers in 1991 gained 13.0 lb (5.89 kg) compared with all other fire fighters who gained 7.7 lb (3.49 kg) ($p > 0.004$). Ex-smokers who had smoked >20 cigarettes per day gained 16.4 lb (7.43 kg) compared with those who smoked up to 19 cigarettes per day who gained 8.3 lb (3.76 kg). Self-reported stress at baseline was not associated with weight change over the 7-year period ($p > 0.05$). However, those who worried over financial security gained 11.2 lb (5.08 kg) versus non-worriers who gained 7.4 lb (3.35 kg) ($p > 0.005$).

In the Whitehall II study poor health control and poor decision latitude at work were related to body mass gain.

Male employees ($n = 1980$) from the Danish National Work Environment Cohort Study were observed for 10 years (Hannerz 2004). Among the background variables, age ($p \le 0.0001$) and baseline BMI ($p \le 0$ 0003) were statistically significant, and the estimates indicated that the tendency to gain weight decreases with age and BMI.

Among the psychological variables, that only ones that interacted significantly with baseline BMI were psychological demand ($p = 0.0108$) and job insecurity ($p = 0.0027$). Obese employees with job insecurity gained more weight than obese employees without job insecurity, whereas underweight employees with job insecurity gained less weight than underweight employees without job insecurity.

A UK study evaluated the effect of unemployment/retirement on weight in middle-aged men (Morris 1992). At initial screening, the mean BMI of men who remained employed was similar to that of men who experienced some non-employment later (25.52 vs. 25.40 kg/m^2, respectively). However, men who later became non-employed were more likely to be underweight compared with men who remained employed (3.8 vs. 2.7%; 95% CI of the difference 0.1, 2.2)

Five years later the mean BMI had risen slightly in both men who had experienced some non-employment (25.40 to 25.71 kg/m^2) and in men who had not (25.52 to 25.77 kg/m^2). The percentage of men who were underweight had fallen 2.7 to 2.0% in men who were employed and 3.8 to 2.3% in men who had experienced unemployment, and the percentage of men who were overweight had risen (8.1 to 8.4% in employed men and 7.9 to 9.4% in men who had experienced non-employment).

Men who experienced some non-employment were less likely to remain a stable weight than men who remained continuously employed. 2.9% of men who experienced some non-employment lost more than 10% in weight and 7.5% gained more than 10% in weight compared with 2.1% and 5.0% respectively of continuously employed men (95% CI of the differenced 0.1, 1.8 for weight loss and 0.9, 4.0 for gain).

The Nurse Health Study II (Field 2004) evaluated the effect of weight loss in female nurses on subsequent weight. During a 2-year period from 1989 to 1991, 2590 (5.5%) women lost 5–9.9% of their 1989 weight and 1326 (2.8%) women lost at least 10% of their 1989 weight. The proportion of women who lost >5% of their baseline weight increased with category of BMI from 3% (5–9.9% weight loss) among women with a BMI <22 kg/m^2 to 9% among women with a BMI >30 kg/m^2 in 1989.

Between 1991 and 1995, approximately 50% of the women had regained all of the weight they had lost. Among those women who had lost >10% of their 1989 weight, the percentage who regained all of their large weight loss between 1989 and 1991 decreased across baseline categories of BMI from 71% among the women with a BMI <22 to 54% among the women with a BMI >30 kg/m^2 in 1989.

Less than 10% of the women who had large clinically significant weight loss between 1989 and 1991 were able to successfully maintain their weight loss. Women who lost greater than or equal to 10% of their weight between 1989 and 1991 gained more weight between 1991 and 1995 than their peers who did not lose weight.

2.2.6 General population

Dietary factors:

Data from the UK 1958 Birth Cohort (Parsons, 2005) reported that a decrease in chip consumption and an increase in fried food consumption was associated with weight gain over a 9-year period in men and women; a decrease in fruit and salad consumption was also associated with weight gain in women only.

Data from a number of other smaller studies found similar relationships. Samuel (2003) reported that a smaller fruit and vegetable consumption, and a greater consumption of sweets, was associated with weight gain in American women over 4 years.

An interesting study from Sweden (Heitmann 1995) found that a high-fat diet was associated with 6-year weight gain in women predisposed to obesity (had a least one fat parent), but not amongst those with lean parents.

Data from a large cohort in Australia (Ball 2002) found that restrictive eating practices and women who reported eating takeaway occasionally were 15% less likely to have maintained their weight over 4 years compared with those who rarely or never ate takeaways. In addition, data from the CARDIA study found similar results.

There was no independent association of frequency of eating with prospective weight change over the preceding 8–10 years in the NHEFS cohort (Kant 1995).

In the Danish MONICA study of 3000 Danish adults (who were evaluated for 5 years retrospectively) night eating was not associated with weight changes for either sex. Obesity did not modify the association between preceding weight change and night eating. Six-years prospective analysis found that for men, night eating was not associated with subsequent weight change. Analysis revealed that obese women with night eating experienced a greater average 6-year weight gain. The total average 6-year weight gain for obese night eating women was 5.2 kg, whereas obese non-night eating women experienced only a 0.9 kg average weight gain.

Nooyens (2005) found that over five years, weight gain and increase in waist circumference in 288 Dutch men aged 50-65 years were associated with a decrease in fruit consumption (p = 0.01) and fibre density of the diet (p = 0.01), and with an increase in frequency of eating breakfast (p = 0.03).

Quatrimoni (2002) found that in 737 non-overweight women from the Framingham Offspring/Spouse cohort, the likelihood of becoming overweight at 12 years follow-up was approximately 29%. The relative risk of developing overweight was RR 1.4; (95 CI 0.9, 2.2) in women who ate an ‘Empty Calorie’ diet that was rich in sweets and fats with fewer servings of nutrient-dense fruits, vegetables, and lean food choices, compared with women who ate a lower-fat, nutritionally varied ‘Heart Healthy’ diet.

Schulz (2005) looked at food patterns and subsequent weight gain nearly 25,000 subjects from the German cohort in the EPIC study. Those with a food pattern of a high consumption of whole-grain bread, fruits, fruit juices, grain flakes/cereals, and raw vegetables, and of low consumption of processed meat, butter, high-fat cheese, margarine, and meat were less likely to gain weight. Mean annual weight gain gradually decreased with increasing pattern score (higher score indicates healthier diet) (p-value for trend < 0.0001), i.e., subjects scoring high for the pattern maintained their weight or gained significantly less weight over time compared with subjects with an opposite pattern. However the prediction of annual weight change by the food pattern was significant only in non-obese subjects, ie dietary patterns predicted weight gain in normal weight subjects by not in those already obese.

Physical activity: Data from the UK 1958 Birth Cohort (Parsons 2005) reported that neither a decrease or increase in PA was associated with weight gain over a 9-year period in men and women. Data from a number of other smaller studies also found no relationship.

However, data from a large cohort in Australia (Ball 2002) found that women who reported moderate or high sitting time were 17–20% less likely to have maintained their weight over 4 years. In addition, a large cohort in America (DiPietro 1998) found that higher baseline levels of PA and lower levels of TV viewing were associated with a lower risk of becoming overweight over a 24-year period. Similar associations were found in other studies (Sundquist 1998; Bell 2001; Droyvold 2004). The PRIME study (Wagner 2004) provided interesting results showing that weight gain over 5 years in a large cohort of men was inversely associated with the amount of PA expended in getting to work, and the practice of high intensity recreational activities.

Nooyens (2005) investigated the effects of retirement on lifestyle and weight and waist circumference in 288 Dutch men. Over five years increases in weight and waist circumference were associated with a decrease in several physical activities, such as household activities, bicycling (p = 0.03), and walking (p = 0.02). Increase in body weight and waist circumference was higher among men who retired from active jobs (0.42 kg per year and 0.77 cm per year, respectively) than among men who retired from sedentary jobs (0.08 kg per year and 0.23 cm per year, respectively).

A small study (Larew 2003) found that lower rates of weight gain over 1 year were associated with greater levels of strength and fitness. Similar results were found in the CARDIA study.

Of note, a study from Sweden (Lissner 1997) found that women’s fat intake was a predictor of 6-year weight gain only amongst women who were sedentary.

Kahn et al. (1990) evaluated the effect of income, education and marriage on weight in data from the NHANES I and NHEFS. The incidence of major weight gain was lowest among men who reported high levels of PA or whose baseline BMI was between 24.0 and 27.8 kg/m^2.

Other behavioural, psychological, social and environmental factors

Viner (2005) UK conducted an analysis of the 1970 British Birth cohort of over 8000 subjects followed up at 5, 10 and 30 years (30 year follow-up self-reported) examining the relationship between television viewing and BMI change. Weekend but not weekday TV viewing in early childhood independently predicted increased adult BMI.

Mean daily hours of TV viewed at weekends predicted higher BMI z-score at 30 years (coefficient=0.03, 95% CI: 0.01, 0.05, P=.01) when adjusted for TV viewing and activity level at 10 years, sex, socioeconomic status, parental BMIs, and birth weight. Each additional hour of TV watched on weekends at 5 years increased risk of adult obesity (BMI > or =30 kg/m2) by 7% (OR=1.07, 95% CI 1.01, 1.13, P=.02). Weekday viewing, type of program and maternal attitudes to TV at 5 years were not independently associated with adult BMI z-score.

Kahn et al (1990) evaluated the effect of income, education and marriage on weight in data from the NHANES I and NHEFS. There was a significant increase in the mean BMI change for men with lower education levels compare with those who had gone beyond 12th grade.

The incidence of major weight gain was generally greater for the men who were not consistently married, among these men there was a higher incidence of major weight gain for those who had lower incomes or lower educational levels. The mid-range weight outcome was generally more common among men who had higher family incomes, or had higher educational levels.

A 7-year follow-up of young US adults in the CARDIA cohort (Greenlund 1996) showed that father's body size was positively associated with participant's baseline BMI among Black men, White men and White women. Mother's body size was positively associated with baseline BMI among all race–sex groups, and with change in BMI among White women. Father's education was inversely associated with baseline BMI among Black men and White women, and with change among White women.

Data from the UK 1946 Birth Cohort (Hardy 2000; Langenberg 2003) and data from the large NHANES I study in USA (Kahn & Williamson 1991) found that weight gain was greatest in Black women, in low income families, and in those with less education. These results were supported by most other studies identified in this review.

Women, but not men, gain weight at the start of marriage and lose weight at the end of marriage (Rauschenbach 1995).

Data from a large cohort in Australia (Ball 2002) found that smoking was significantly associated with a decreased likelihood of maintaining weight over 4 years in women. Data from a large cohort in Norway (Droyvold 2004) also found that those who did not drink alcohol were less likely to gain weight over a 9-year period.

A study (Samuel, 2003) found weight gain in US women over 4 years was associated with those more likely to have a high anxiety score, and those who had a lower average Quality of Life score. A small study (Tiggerman 2004) found the neither dietary restraint nor self-esteem alone predicted weight change over 4 years, but those who put on the least amount of weight over time were those low in dietary restraint and high in self-esteem.

2.3 Evidence of corroboration in the UK

Five of cohorts of adults were conducted in the UK, with the majority conducted in the USA and generalisable to UK adults. There were also cohorts in Japan, Chile, China, Australia, Norway, Sweden, Denmark and France.

UK studies were:

- MacDonald (2003) study of weight and menopause conducted in UK.
- Fifty-three year follow-up of UK men and women assessed associations between childhood weight and SES and weight change (Hardy 2000).
- Parsons (2005) followed all births 3–9 March 1958 in England, Scotland and Wales (16,000) and studied at age 33 and at age 42 years and assessed associations between diet and PA factors and weight change.
- Maartikainen (1999) assessed employment grade and weight change in the UK civil servants.
- Morris (1992) study of unemployment and retirement in men from one GP practice in UK followed for 5 years.

Evidence of implementation not valid for this review as not intervention studies.

EVIDENCE TABLES: DETERMINANTS OF WEIGHT GAIN/CONTROL IN ADULTS

First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
REVIEWS OF COHORT STUDIES				
Williamson 1996 (2++) Review of eight cohort studies (1990–95, all at least 12 months follow-up, measuring dietary intake and/or PA) including:				
Colditz 1990 Nurses Health Study	US female nurses in 11 states 31,940 women aged 30–55 years (excluded women diagnosed with coronary heart disease, cancer, diabetes, smokers, on special diets, >15 g alcohol per day, pregnant, at least ten food items blank, total food score implausibly high or low, missing body weight.	**Year of baseline survey:** 1976 **Duration of follow-up:** 8 years **Outcome variable:** Absolute and percent weight change within 2 time periods: 1978–80 and 1980–84. **Self-reported or measured weight:** Self-reported every 2 years from 1976. **Statistical analysis:** • Pearson correlation • Linear regression	**Weight changes:** • From 1976 to 1984: 74% gained weight, 18% lost weight, 8% stayed at same weight. • Mean weight change (kg): 1976–80 +1.9 kg; 1980–84 +1.6 kg • Inverse correlation between weight change in a 2-year period and contiguous 2-year weight change, mean $r = 0.30$. • Weight change correlations involving non-contiguous periods were nearly 0. **Association of diet with weight change:** **Retrospective** (1978–80) weight change regressed on diet in 1980): • Total energy: ß = 0.00025 ($p > 0.0001$). (For every 1000 kcal [4.2 kJ]/day increase, body weight increased 0.25 kg.) • Total fat: ß = 0.0055 ($p > 0.001$). (For every 100 g/day increase, body weight increased 0.55 kg.) **Prospective** (1980–84 weight change regressed on diet in 1980): • Total energy: ß = 0.000021 ($p = 0.67$). • Total fat: ß = 0.0007 ($p = 0.69$). **Association of physical activity with weight change:** Not assessed.	Age, BMI, total energy and prior weight change in 1978–80.
Rissanen 1991	Twelve communities in Finland, 6165 men, 6504 women, aged 25–64 years	**Year of baseline survey:** 1966–72. **Duration of follow-up:**	**Weight change:** • Mean weight change (kg): +0.6 for men, +0.1 for women. • Range: –36 to +42 for men, –40 to +32 for women. • Prevalence of ≥5 kg gain: 18% for men, 15% for women. **Association of diet with weight change:**	Age, BMI, education, marital status, parity, smoking, alcohol, coffee, PA. 'Health

<table>
<tr>
<td></td>
<td>(excluded pregnant women)

Baseline BMI:
not reported</td>
<td>5.7 (median).

Outcome variable:
• Absolute weight change.
• Odds of gaining ≥5 kg.

Self-reported or measured weight:
Measured.

Statistical analysis:
• Analysis of covariance
• Logistic regression</td>
<td>OR for gaining ≥5 kg for quintiles of total energy intake (compared with lowest quintile):

<table>
<tr><th>Quintile</th><th></th><th>Men</th><th>Women</th></tr>
<tr><td>Low</td><td>1</td><td>1.0</td><td>1.0</td></tr>
<tr><td></td><td>2</td><td>0.7 (NS)</td><td>1.3(NS)</td></tr>
<tr><td></td><td>3</td><td>0.7 (NS)</td><td>1.2 (NS)</td></tr>
<tr><td></td><td>4</td><td>1.0 (NS)</td><td>1.5 (NS)</td></tr>
<tr><td>High</td><td>5</td><td>0.8 (NS)</td><td>2.0 (p > 0.05)</td></tr>
</table>
OR for gaining ≥5 kg for highest vs. lowest quintile (other quintiles not reported).

Women (p > 0.05):
<table>
<tr><th>Fat</th><th>Protein</th><th>Carbohydrate</th></tr>
<tr><td>1.7</td><td>2.0</td><td>1.7</td></tr>
</table>

(No association found in men.)</td>
<td>status' (self-report of diabetes, hypertension, or 'other chronic diseases').</td>
</tr>
<tr>
<td>Klesges 1992

Aim:
To determine the relationship between dietary intake, PA and weight change.</td>
<td>Middleclass White adults from Memphis, TN, USA, who participated in a study examining cardiovascular risk factors in adults and their young children; 142 men mean age 34.8 years, 152 women mean age 33.1 years.

Baseline BMI:
27.8 (4.32) kg/m^2 men, 24.83 (4.96) kg/m^2 women.</td>
<td>Year of baseline survey:
Not reported.

Duration of follow-up:
2 years (seen once a year for 3-years to longitudinally predict weight gain over a 2-year period).

Outcome variable:
Weight change (kg).

Self-reported or measured weight:
Measured.

Statistical analysis:
Stepwise regression.</td>
<td>Attrition:
Approx. 30% (123 of 417)

Weight changes:
Mean weight change (kg): 0.265 (4.55) for men, 1.37 (5.89) for women at 2 years.

Association of diet with weight change:
Women:
Total energy, ß = 0.004 (p = 0.0407) (for every 1000 kcal [4.2 MJ]/day increase, body weight increased 4 lb [1.8 kg]).
%Energy (fat), ß = 0.527 (p = 0.0010) (for every 5% increase in fat, body weight increased 2.6 lb (1.2 kg).
Change in total energy, ß = 0.005 (p = 0.0289) (for every 1000 kcals [4.2 MJ]/day increase body weight increased 5 lb [2.3 kg]).
Men:
Total energy, ß = –0.003 (p = 0.0235)
Change in fat intake, ß = 0.383 (p = 0.0216)
Change in total kcal, ß = –0.002 (p = 0.1181)

Association of physical activity with weight change:

Women:</td>
<td>Age, BMI, smoking, alcohol, 'familial risk for obesity', pregnancy.

Stepwise regression may have lead to important confounders being dropped (some results are not intuitive, i.e. increases in energy intake associated with weight gain in men).

Not clear how authors coded work, sports,</td>
</tr>
</table>

			Work ß = –3.54 (*p* = 0.0939) Sports ß = +3.02 (*p* = 0.0582) Leisure ß = –6.18 (*p* = 0.0003) Change in work ß = –5.87 (*p* = 0.0221) **Men:** Sports ß = +1.86 (*p* = 0.0920) **Association of other factors with weight change:** cigarette consumption Change in cigarette consumption in women, ß = –0.707 (*p* = 0.0001). **Summary of results:** Longitudinal regression model explained 32.45 total variability of weight change in women (*p* > 0.0001) *and* 12% total variability of weight change for men (*p* = 0.0035). Higher total energy intake at baseline was directly related to subsequent weight gain in women whereas relationship was inverse in men. %Energy from fat at baseline directly related to weight gain only in women. Increased total energy intake was directly related to weight gain in women (increase in 200 kcal (840 kJ)/day for 2 years resulted in 2.206 kg weight gain) and the inverse for men (not significant for men). In men increases in % energy from fat was related to weight gain (5% increases in fat intake over 2 years resulted in weight gain of 0.86 kg). Higher work and leisure activity in women at baseline was associated with lower weight gain and decrease in work activity during follow-up was associated with higher weight gain. In both men and women higher baseline sports activity was associated with increase in subsequent weight gain and higher baseline weight was associated with less weight gain in men and women. Women who became pregnant gained weight and those initially pregnant (5%) lost weight compared with those with no change in pregnancy status. An increase of five cigarettes per day in women resulted in 1.586 kg decrease in weight over 2 years.	leisure. **Author's conclusions:** Different pattern of predictors for weight change for men and women; for women a high dietary energy and fat intake as well as increases in total energy intake were related to higher weight gain and increases in work activity levels were related to decreased weight gain; for men weight gain was predicted by increases in dietary fat intake.

Owens 1992	Women whose names appeared on motor vehicle license data in Allegheny County, Pennsylvania 500 women participated in the study. Age 42–50 years	**Year of baseline survey:** 1983–84 **Duration of follow-up:** 3 years **Outcome variable:** Absolute weight change **Self-reported or measured weight:** Measured **Statistical analysis:** Linear regression	**Weight change:** Mean weight change: +4.9 lb (2.2 kg) **Association of diet with weight change:** Not reported. **Association of physical activity with weight change:** Baseline activity expressed as 'Log kcal/week' • ß = 1.2*9 lb. (*p* > 0.003) (For every log kcal increase in activity there was a decrease in weight gain of –1.29 lb. Change in activity: • ß = –0.00058 lb (*p* > 0.01) (For every 1000 kcal [4.2 MJ]/week increase in activity there was a 0.58 lb [0.26 kg] decrease in weight gain)	Hormone use, smoking status, change in menopausal status during study.

<table>
<tr>
<td>Williamson 1993</td>
<td>National sample of USA aged 25–74 years.

3515 men, mean age 48 years

5810 women, mean age 46 years.</td>
<td>Year of baseline survey:
1971–75

Duration of follow-up:
10 years

Outcome variable:
Weight change (kg)
Weight gain categories (kg: ≤3 to ≤8, >8 to ≤13, >13

Self-reported or measured weight:
Measured.

Statistical analysis:
Linear regression.
Logistic regression.</td>
<td>Weight changes:
Mean weight change (kg) +0.3 for men, +0.7 for women.

Association of diet with weight change:
Not reported.

Association of physical activity with weight change:
Effect on mean weight change (kg):
• No association with baseline activity
• Association with follow-up activity: p > 0.05
<table>
<tr><th>Activity</th><th>Men</th><th>Women</th></tr>
<tr><td>High</td><td>0.0</td><td>0.0</td></tr>
<tr><td>Moderate</td><td>0.9</td><td>1.4</td></tr>
<tr><td>Low</td><td>+1.6</td><td>+1.9</td></tr>
</table>
• Association with change in activity (p > 0.05):
<table>
<tr><th>Activity</th><th>Men</th><th>Women</th></tr>
<tr><td>Stayed high</td><td>0.0</td><td>0.0</td></tr>
<tr><td>Decreased</td><td>+1.4</td><td>+1.9</td></tr>
</table>
Effect on gaining >13 kg (OR):
• No association with baseline activity
• Association with follow-up activity (p > 0.05)
<table>
<tr><th>Activity</th><th>Men</th><th>Women</th></tr>
<tr><td>Stayed high</td><td>1.0</td><td>1.0</td></tr>
<tr><td>Decreased</td><td>2.3</td><td>6.2</td></tr>
</table>
</td>
<td>Age, BMI, race, education, smoking status, alcohol, physician-diagnosed health conditions, parity.</td>
</tr>
<tr>
<td>French 1994</td>
<td>Persons employed in 32 companies in Minnesota (part of a health promotions study)

1639 men participated and</td>
<td>Year of baseline survey:
1988

Duration of follow-up:
2 years

Outcome variable:
Body weight at follow-</td>
<td>Weight change:
Mean weight change: +0.9 lb (0.4 kg) for men, +1.4 lb (0.63 kg) for women.

Association of diet with weight change:
(‘Cross-sectional’ because baseline and follow-up measures included in same model).

Results expressed as increase of one serving per week.

Women:</td>
<td>History of dieting, age, education, occupational, marital status, smoking status, treatment group.</td>
</tr>
</table>

	1913 women. Mean age: 38 years.	up. **Self-reported or measured weight:** Measured. **Statistical analysis:** Linear regression.	French fries: +0.55 lb (0.29 kg) (*p* = 0.03) Sweets: +0.28 lb (0.13 kg) (*p* = 0.003) Diary products: +0.18 lb (0.08 kg) (*p* = 0.05) Meat: +0.35 lb (0.16 kg) (*p* = 0.0007) **Men:** Sweets: +0.19 lb (0.09 kg) (*p* = 0.02) Eggs: +0.52 lb (0.24 kg) (*p* = 0.006)	
Taylor 1994	Persons from four communities in Northern California (part of a health promotion study). 568 men 668 women Age 20–60 years.	**Year of baseline survey:** 1980–82 **Duration of follow-up:** 7 years **Outcome variable:** BMI change per year ('BMI slope' estimated by regression of BMI on time). **Self-reported or measured weight:** Measured **Statistical analysis:** Linear regression.	**Weight change:** Weight change expressed as mean 'BMI slope' • Stratified by sex, age, and smoking status. • Maximum BMI slope: Men: +0.44, 45–54 years olds who quit smoking. Women: +0.46, 45–54 year olds who quit smoking. • Minimum BMI slope: Men 0.00, 55–64 years old, smokers. Women +0.04, 55–64 years old, non-smokers. **Association of diet with weight change:** Authors stated that: 'Dietary habits had inconsistent effects on BMI slope. No dietary results reported. **Association of physical activity with weight change:** ('Cross-sectional' because baseline and follow-up measures included in same model) • Association expressed as difference in BMI slope between sedentary persons who increased their activity and those who didn't. **Women** • Non-smoker –0.06 (*p* > 0.05) • Smoker –0.14 (*p* > 0.05) • Quit smoking –0.09 (*p* > 0.05) **Men** • Non-smoker –0.05 (*p* > 0.05) • Smoker –0.03 (NS) • Quit smoking –0.15 (*p* > 0.05)	Age. All analyses were stratified by smoking status and sex.
Kant 1995 Same as study by Williamson	National sample of US adults aged 25–74 years.	**Year of baseline survey:** 1971–74	**Weight change:** Mean weight change (kg): +2.1 for men, +2.5 for women. **Largest mean weight gain (kg):**	Race, income, smoking status, non-recreational PA, length of

et al., but did not subtract estimated weight of clothing at follow-up survey.	2580 Men 4564 Women Mean age: 45 years	**Duration of follow-up:** 10.6 years (mean) **Outcome variable:** Absolute weight change. **Self-reported or measured weight:** Same as study by Williamson et al., but did not subtract estimated weight of clothing at follow-up survey. **Statistical analysis:** Linear regression	Men +4.8, 25–34 years old, in upper quartile of % energy as fat. Women +6.0, 25–34 years old, in lower quintile of % energy as fat. **Smallest mean weight change (kg):** Men –2.7, 65–74 years old, in lower quintile of % energy as fat. Women –3.8, 65–74 years old, in second quartile of % energy as fat. **Association of diet with weight change:** No association found with total energy. Inconsistent associations found with % energy as fat. **Men** (age >50 years) ß = 0.06 (p = 0.10) If % energy as fat increases by 10% then weight increases by 0.6 kg. **Women** (age <50 years) ß = 0.05 (p = 0.04) If % energy as fat increases by 10% then weight decreases by 0.5 kg. **Association of physical activity with weight change:** Not reported.	follow-up, total energy, BMI, alcohol, special diet status, parity. Models were also stratified by age and by quartile of total energy, non-recreational PA, BMI, and physician-diagnosed morbidity.
Summary of Williamson's conclusions of review: Results of associations between dietary and PA variables and weight change were inconsistent.				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
Saris 2003 (2++) – review of 13 cohort studies (1990–2001 all at least 4 years, estimating PAL and BMI) including:				
Kahn 1997, 1998 **Aim:** To identify behaviours associated with change in BMI	79,236 White, non-Hispanic healthy adults from 21 selected sites initially recruited for Cancer Prevention	**Year of baseline survey:** 1982 **Duration of follow-up**: 10 years **Outcome variable**:	**Attrition:** Unclear. **Weight changes:** 10-year BMI change for men was 0.6 (1.7) and for women was 1.4 (1.9) kg/m^2. **Association of diet with weight change:**	To obtain original studies and ascertain if reported any other factors associated with weight change.

or with weight gain at the waist. Kahn 1997 included in Saris review and Kahn 1998 identified as individual study but included here as same study	Study II in USA, aged between 50–74 years of age at follow-up; analysis excluded subject who were more than 54 years at baseline, regular diuretic use, cancer history other than non-melanoma skin cancer, diabetes, race/ethnicity other than White non-Hispanic, BMI >32 or <18 kg/m^2, or decrease/increase of greater than 8 kg/m^2 in BMI or 3% over 10 years, or misreported height or weight data. **Baseline BMI:** 25.6 (2.6) kg/m^2 for men, 23.4 (3.0) kg/m^2 for women	Change in BMI. **Self-reported or measured weight:** Self-report **Statistical analysis**: Multivariate linear regression (sex-specific) for change in BMI associated with specific behaviours, multivariate unconditional logistic regression for weight gainers vs. non gainers for weight gain at the waist.	Meat consumption greater than 3 days or servings per week was associated with BMI increase, more strongly for men than women, decrease in BMI for people who consumed greater than 19 days or servings per week of vegetables. **Association of physical activity with weight change:** Jogging/running 1–3 hours per week associated with decrease in BMI (0.2 kg/m^2 for men and 0.5 kg/m^2 for women), for men who performed this activity for ≥4 hours per week there was slightly greater decrease in BMI (0.3 kg/m^2); very few women reported jogging/running for more than 4 hours per week ('impossible to show significant effect'). Aerobics/callisthenics for men at any level was associated with BMI reduction similar to finding for men's jogging/running; for women there was a BMI decrease associated with aerobics/callisthenics performed at least 4 hours per week but not 1–3 hours per week. Tennis/racquetball associated with significant decrease in BMI for women at least 1–3 hours per week but no mean effects on BMI change for lap swimming, bicycling/stationary bike, or dancing. No significant effect on BMI change for heavy housework/vacuuming or heavy home repair/painting, but gardening/mowing/planting was associated with decreases in BMI for men at ≥4 hours per week and for women at ≥1 hours per week (0.1 kg/m^2 both sexes). Walking was highly prevalent activity but no significant effect found on BMI change for persons walking 1–3 hours per week, people who walked ≥4 hours per week experienced small significant decrease in BMI (twice as much for women). Women showed the greatest loss in BMI following PA. In men, those who did gardening or mowing for between 1 and 3 hours per week showed an decrease of –0.03 kg/m^2 while those who did 4 hours showed an decrease of –0.11 kg/m^2 in BMI. Men who walked for between 1 and 3 hours per week showed an increase of +0.01 kg/m^2 and those who did more than 4 hours showed an decrease of –0.8 kg/m^2.	**Adjusted for:** Age, education, BMI at baseline, slope of BMI between 18 years age and baseline, marital status, four regions of the country, estimated total daily energy intake in 1992, smoking, diet, PA and other behavioural characteristics, for women model also adjusted for parity, menopausal status and oestrogen replacement therapy. **Author's conclusions:** Ten-year change in BMI associated positively with meat consumption and smoking cessation and inversely with vegetable consumption, vitamin E

			For women, those who did between 1 and 3 hours of gardening/mowing showed an decrease of –0.09 kg/m^2 and for those who did >4 hours showed an decrease of –0.14 kg/m^2. For those who did between 1 and 3 hours of walking per week showed no change (0.00 kg/m$^{2)}$ and those who did >4 hours showed an decrease of –0.16 kg/m^2 in BMI. **Association of other factors with weight change:** • Vitamin E supplementation ≥100 IU (67 mg α-tocopherol equivalent)/day was associated with BMI decrease of about 0.1 kg/m^2 for men and women; people who continued to smoke experienced modest decrease in BMI (0.2 kg/m^2 for men and 0.3 kg/m^2 for women). The largest mean effect on 10-year BMI was associated with smoking cessation, in comparison with those who did not smoke, quitters experienced an increase of 1.0 kg/m^2. • Men who regularly consumed beer there was a decrease in BMI of 0.1 kg/m^2 but no effect associated with wine or liquor; for women who regularly consumed any form of alcohol experienced a decrease in BMI that was most marked for beer (0.4 kg/m^2) and least marked for wine (0.1 kg/m^2). • Men's likelihood of weight gain at the waist was positively associated with the Household Inequality Index (HII) (*p* = 0.0008), men with a high HII (households above the median receive 81.6 to 82.6% of the income) described weight gain at the waist more often than men from states with a low HII (households above the median receive 77 to 78.5% of the income), OR = 1.12, 95% CI 1.03, 1.22); women's results showed non significant trend in same direction.	supplementation, continued smoking and some vigorous activities. Women's BMI decreased with walking ≥4 hours per week and with regular alcohol intake but these behaviours had smaller effect on men's BMI; also results for waist circumference gain reported in paper. **Conclusion from Saris review:** The main effect of PA had a positive effect of weight gain.
Lee et al. 1993 **Aim:** To investigate body weight and mortality in middle-aged men.	17321 male adults (mean age 46 years) who were Harvard alumni, USA.	**Year of baseline survey:** 1962 **Duration of follow-up:** 12–16 years **Self-reported or measured weight:** BMI	**Association of physical activity with weight change:** No relationship between total or vigorous activity and BMI.	The main effect of PA on weight level of the subjects was non-significant.

		Statistical analysis: Not stated.		
Rissanen et al. 1991 **Aim:** To investigate the determinants of weight gain and overweight in adult Finns.	6165 males and 6504 female adults from Finland with an average age of 25–64 years.	**Year of baseline survey:** 1966 **Duration of follow-up:** Median 5.7 years. **Outcome variable**: BMI **Self-reported or measured weight:** Not reported. **Statistical analysis**: Not stated.	**Association of physical activity with weight change:** PA at follow up was inversely associated with weight gain in men and women. The percentage of men with a BMI >30 kg/m^2 was rare in 14.2% of men, occasional in 11.2% of men and frequent in 6.7% of men. In women 21.4% of women rarely had a BMI >30 kg/m^2, 14.1% occasionally and 8.0% frequently. The table below shows the estimated PAL of men and women in the study: (table) | Men | Women **Rare** | 1.5 | 1.4 **Occasional** | 1.65 | 1.55 **Frequent** | >1.8 | >1.7	Statistical adjustments were made for age, education, marital status, parity, smoking, alcohol, coffee, health status. The main effect of PA had a positive effect of weight gain.
Williamson et al. 1993 (also included in Williamson review) **Aim:** To investigate recreational PA and 10-year weight change in a US national cohort.	3515 males and 5810 females with a mean age of 47 years from the USA.	**Year of baseline survey:** 1971 **Duration of follow-up:** 10 years **Outcome variable**: BMI **Self-reported or measured weight:** Not reported. **Statistical analysis**: Not clear.	**Association of physical activity with weight change:** Weight change was inversely associated with PA at follow up. Decreased PA was associated with weight gain. Baseline PA was not associated with weight change.	Statistical adjustments were made for age, BMI, race, education, smoking status, alcohol, physician-diagnosed health conditions, parity. The main effect of PA had a positive effect of weight gain.
Heitmann et al. 1997 Finnish Twin Cohort Study	2110 males and 2490 women (twin pairs) aged between 18 and 39 years	**Year of baseline survey:** 1975 **Duration of follow-**	**Association of physical activity with weight change:** PA at follow up was significantly associated with weight change in group overall. The table below shows the effect of doing differing intensities on BMI:	Age adjusted for all twins. The main effect of PA had a

<table>
<tr>
<td>Aim:
To investigate whether the genetic determinants of weight gain modified by LTPA in twins.</td>
<td>from Finland.

Of these, 1571 monozygotic and 3029 dizygotic, same-sex twin pairs.

Baseline BMI, mean (SD):
Men: 23.0 (2.7) kg/m^2
Women: 21.0 (2.6) kg/m^2</td>
<td>up:
6 years

Outcome variable:
BMI

Self-reported or measured weight:
Self-reported.

Statistical analysis:
Not clear, various, separate analyses of gene–PA interactions.</td>
<td>
<table>
<tr><th>Intensity</th><th>Men</th><th>Women</th></tr>
<tr><td>Low PA</td><td>24</td><td>22</td></tr>
<tr><td>Moderate PA</td><td>24</td><td>21.8</td></tr>
<tr><td>High PA</td><td>23.6</td><td>21.7</td></tr>
</table>
The table below shows the estimated PAL of men and women in the study:
<table>
<tr><th>Intensity</th><th>Men</th><th>Women</th></tr>
<tr><td>Low PA</td><td>1.5</td><td>1.4</td></tr>
<tr><td>Moderate PA</td><td>1.65</td><td>1.55</td></tr>
<tr><td>High PA</td><td>>1.8</td><td>>1.7</td></tr>
</table>
Simple correlations revealed negative and insignificant associations between PA level and weight gain in men and women.

Other results are presented, but these compare effects by type of twin.
</td>
<td>positive effect of weight gain.

In conclusion, the author's state that the study shows that genetic factors may modify the effects of PA on weight change, and suggest that a sedentary lifestyle may have an obesity-promoting effect in men with a genetic predisposition.</td>
</tr>
<tr>
<td>Morris et al. 1990

Aim:
To effect of PA/exercise in leisure time and its effect on body weight, coronary attack and death rates.</td>
<td>2250 male adults from the UK aged between 45 and 64 years.</td>
<td>Year of baseline survey:
1976

Duration of follow-up:
9.33 years

Outcome variable:
BMI

Self-reported or measured weight:
Not reported.

Statistical analysis:
Not stated.</td>
<td>Association of physical activity with weight change:
The more frequently subjects exercised the less likely there were to have a larger BMI (kg/m^2). This is shown by the table below:
<table>
<tr><th></th><th>% of subjects BMI > 27</th></tr>
<tr><td>None</td><td>24</td></tr>
<tr><td>Residual</td><td>18</td></tr>
<tr><td>Less frequent</td><td>14</td></tr>
<tr><td>Frequent</td><td>10</td></tr>
</table>
The table below shows the estimated PAL of the subjects in the study:
<table>
<tr><th>Intensity</th><th>Men</th></tr>
<tr><td>None</td><td>1.6</td></tr>
<tr><td>Residual</td><td>1.78</td></tr>
<tr><td>Less frequent</td><td>1.8</td></tr>
</table>
</td>
<td>The main effect of PA had a positive effect of weight gain.</td>
</tr>
</table>

			Frequent 1.9	
Guo et al. 1999 **Aim:** The study was part of the Fels Longitudinal study, which looked at the effects of aging, body composition and lifestyle.	102 men and 108 women from the USA with a mean age of 44 years.	**Year of baseline survey:** 1976 **Duration of follow-up:** 9.1 years (mean). **Outcome variable**: Body weight (kg). **Self-reported or measured weight:** Not reported. **Statistical analysis**: Not clear.	**Association of physical activity with weight change:** Low and medium PA was significantly associated with increased body fat in both men and women, as shown in the table below: **Intensity** / **Men (kg)** / **Women (kg)** **Low PA**: 2.53 / 7.5 **Moderate PA**: 1.33 / 3.52 The table below shows the estimated PAL of the subjects used in the study: **Intensity** / **Men** / **Women** **Low PA**: 1.5 / 1.4 **Moderate PA**: 1.65 / 1.55 **High PA**: >1.8 / >1.7	Statistical adjustments were made for age, menopausal status and duration of oestrogen use. The main effect of PA had a positive effect of weight gain.
Sesso et al. 2000 **Aim:** The study investigated PA and coronary heart disease in men.	12,516 men from the USA, with the mean age of 58 years, who were all Harvard Alumni.	**Year of baseline survey:** 1977 **Duration of follow-up:** 16 years. **Outcome variable**: BMI **Self-reported or measured weight:** Not reported. **Statistical analysis**: Not stated.	**Association of physical activity with weight change:** There was no significant difference in BMI's of subjects regardless of total PA done by the subjects per week	The main effect of PA did not have a significant effect on weight gain.
Haapanen et al 1997 **Aim:** The study investigated	2564 males and 2695 females of working age (19–63 years) from Finland.	**Year of baseline survey:** 1980 **Duration of follow-up:**	**Association of physical activity with weight change:** Those who were involved in more vigorous type exercise two or more times a week had the higher weight increases compare with those who did no regular weekly PA. Those who had no regular weekly PA showed a 1.5 kg increase and 1.9 kg increase for men and women respectively.	Statistical adjustments were made for age, perceived health smoking and SES.

the association between LTPA and 10-year body mass change among working aged men and women.		10 years **Outcome variable**: Body weight (kg). **Self-reported or measured weight:** Not reported. **Statistical analysis**: Not clear.	Men who did weekly light intensity PA had a 2.7 kg weight increase while women showed a 3.0 kg increase. Men who took part in vigorous PA once per week plus light PA showed an increase of 3.0 kg while women showed a 2.8 kg increase. Finally, men who took part in vigorous PA two or more times per week showed a 3.2 kg weight increase while women showed a 3.1 kg increase. NB: All activities including unusual jogging, aerobics and tennis significantly inversely related to weight gain	The main effect of PA had a positive effect of weight gain.
Thune et al. 1998 **Aim:** This was part of the Tromso study, which investigated the effect of PA on metabolic risk profiles in men and women	5220 men and 5869 women from the USA, aged between 20 and 49 years.	**Year of baseline survey:** 1982 **Duration of follow-up:** 7 years. **Outcome variable**: BMI **Self-reported or measured weight:** Self-reported. **Statistical analysis**: Not clear.	**Association of physical activity with weight change:** Sustained high or increased PA was associated with less weight gain during follow up period. Men who were sedentary had a BMI of 25.7 kg/m^2, those who did moderate amounts of PA had a BMI of 25.0 kg/m^2, those who did hard levels of PA had a BMI of 24.5 kg/m^2 and those who did very hard had a BMI of 23.9 kg/m^2. Women who were sedentary had a BMI of 23.6 kg/m^2, those who did moderate PA had a BMI of 23.5 kg/m^2 and women who did hard PA had a BMI of 23.1 kg/m^2.	Statistical adjustments were made for age, smoking, coffee, dietary fat and menopausal status. The main effect of PA had a positive effect of weight gain.
Coakley et al 1998 **Aim:** This was part of the Health professionals follow-up study which looked at predictors of weight change in men.	10,272 males from the USA, aged between 44 and 54 years.	**Year of baseline survey:** 1986 **Duration of follow-up:** 4 years **Outcome variable**: Body weight (kg). **Self-reported or measured weight:**	**Association of physical activity with weight change:** Those who did more vigorous leisure-time PA (LPTA) showed the smallest increases in body weight. **Weight change**: 44–54 years old, mean weight at 4 years follow-up: 82.6 kg (increase of 1.4 kg). 55–64 years old, mean weight at 4 years follow-up: 81.4 kg. >65 years old, mean weight at 4 years follow-up: 78.4 kg (decrease of 0.2 kg). Overall mean weights at 4 years follow-up: 81.5 kg (increase of 0.8 kg). **Association of diet with weight change:**	Statistical adjustments were made for age, diet, smoking, baseline values (including PA and TV use), weight, height, blood pressure and cholesterol. **Authors'**

		Self-reported. **Statistical analysis**: Multivariate regression analyses.	Eating between meals was associated with weight gain. Recently being on diet was more strongly associated with weight loss among older men. **Association of physical activity with weight change:** Those who decreased their vigorous LTPA by 1.5 hours a week showed a 1.7 kg weight increase. Those who maintained less than 1.5 hours of vigorous LPTA per week showed a 1.1 kg increase in body weight while those who maintained over 1.5 hours of vigorous LPTA showed an increase of 0.8 kg of body weight. Finally, those who increased their vigorous LPTA to >1.5 hours showed an increase of only 0.2 kg of body weight. Vigorous activity was associated with weight reduction and TV/video viewing with weight gain. The prevalence of obesity among middle-aged men was lowest among those who maintained a relatively high level of vigorous PA, compared with those who were relatively sedentary. **Association of other factors with weight change (please state factors):** Quitting smoking and a history of voluntary weight loss prior to the study period were consistently related to weight increase. Middle-aged men who increased their exercise decreased their TV viewing and stopped eating between meals, lost an average weight of 1.4 kg, compared with a weight gain of 1.4 kg among the overall population.	**conclusions:** increasing vigorous activity, as well as decreasing TV use and changing eating habits, results in weight maintenance or a modest weight loss over 4 years.
Wier et al. 2001 **Aim:** To determine the amount of PA needed for long-term weight control.	341 males, with a mean age of 42.1 years and 155 females with a mean age of 36.1 years who were all employees from the NASA space centre in the USA.	**Year of baseline survey:** 1990 **Duration of follow-up:** 5.5 years for males and 4.9 years for females. **Outcome variable**: Body weight (kg). **Self-reported or measured weight:** Not stated. **Statistical analysis**:	**Association of physical activity with weight change:** Average weight gain progressively limited for both males and females at levels of PA. Men who were inactive showed a 1.7 kg increase in body weight while women showed an 8.8 kg increase. Moderately active men showed a 1.3 kg increase in body mass while women showed a 1.1 kg increase. Active men showed a 0.5 kg increase in weight while women showed a 0.7 kg increase. Very active men showed a 1.3 kg decrease in body weight while women showed a 3.1 kg body weight decrease.	Statistical adjustments were made for age and initial weight as well as time elapsed. The main effect of PA had a positive effect of weight gain.

		not stated		
Ball et al. 2001 **Aim:** This study looked at the associations of PA with body weight and fat in men and women.	1301 male and females aged 18–78 years from Australia.	**Year of baseline survey:** 1990 **Duration of follow-up:** Not stated. **Outcome variable**: % Overweight. **Self-reported or measured weight:** Self-reported. **Statistical analysis**: Not stated.	**Association of physical activity with weight change:** The percentage of males overweight was higher than the percentage of women overweight regardless if they were sedentary, had low levels of PA or high levels of PA. 50% males who were sedentary were overweight while only 35% of sedentary females were overweight. 42% males who were had low levels of LTPA were overweight while 27 % of women who had low levels of LTPA were overweight. 34% of males who had high activity LTPA levels were overweight while only 20% of women who had high levels of LTPA were overweight.	The main effect of PA had a positive effect of weight gain.
Summary of Saris's conclusions of review: 30 min of exercise is insufficient to prevent weight gain for many individuals. Between 45–60 min or 1.7 PAL per day of moderate intensity exercise is required to prevent the transition of being overweight to obese; this is likely to be more for children.				
INDIVIDUAL COHORT STUDIES: MENOPAUSE				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
MacDonald 2003 Prospective cohort 2+ **Aim:** To investigate whether energy intake or energy	1064 initially premenopausal White women aged 45–54 (mean 48 years) years selected from a randomly selected osteoporosis screening programme in	**Year of baseline survey:** 1993 **Duration of follow-up**: 6.2 (0.6) years **Outcome variable**: Mean weight change. **Self-reported or measured weight:**	**Attrition:** 85.2% (*n* = 907) women returned for follow-up of which 898 completed questionnaires **Weight changes:** Difference weight (kg): premenopausal (*n* = 51) 3.08 (4.45), perimenopausal (*n* = 117) 3.68 (5.29), postmenopausal (*n* = 328) 3.02 (5.32), past HRT use (*n* = 115) 4.41 (5.19), present HRT use (*n* = 284) 2.99 (4.63). **Association of diet with weight change:** Alterations in dietary intake had small but significant effect (0.6%,	**Author's conclusions:** Mean weight had increased and was influenced more by reduced energy expenditure than increased energy intake, HRT and dietary

expenditure affects 5–7-year weight gain in perimenopausal and early postmenopausal women and whether HRT use or dietary calcium intake are contributory factors.	Aberdeen, Scotland, not on HRT at baseline or suffering from any condition or taking any medication that would interfere with bone metabolism. **Baseline BMI:** 24.6 (4.0) kg/m^2.	Measured. **Statistical analysis**: Multiple regression analysis.	*p* = 0.013). **Association of physical activity with weight change:** Changes in PAL influenced weight change explaining 4.4% (*p* = 0.001) of the variation. **Association of other factors with weight change: calcium intake** Dietary calcium intake had no effect on weight or weight change; including menopausal status and HRT use as variables in the regression did not add significantly to the model.	calcium intake did not influence weight gain.
Nagata 2002 Prospective cohort 2+ **Aim:** To evaluate the effect of menopause on weight change in Japanese women.	828 Japanese premenopausal women aged 40–54 years randomly selected from women participating in Takayama study; excluded menopause by surgery (*n* = 25), or by radiation/medication (*n* = 9) those who did not report weight (*n* = 16) or menopausal status (*n* = 1), reported history of cancer (*n* = 2). **Baseline BMI:** (adjusted for age at baseline)	**Year of baseline survey:** 1992 **Duration of follow-up**: 6 years. **Outcome variable**: Change in weight (kg). **Self-reported or measured weight:** Self-report (intraclass coefficients between self-report and measured weight of women in another sample form Takayama study) was 0.97. **Statistical analysis**: Regression model.	**Attrition:** 81% response rate. **Weight changes:** Weight gain (kg) (adjusted for age and weight at baseline) premenopausal at follow-up: 0.41 (SE 0.18); postmenopausal at follow-up: –0.18 (SE 0.19); years since menopause at follow-up 1–2 years: –0.26 (SE 0.29); ≥3 years: –0.04 (SE 0.25). Weight gain was significantly higher in women who remained premenopausal at follow-up compared with those who had natural menopause; weight change was less in women who were postmenopausal more than 2 years than those in first or second year of menopause but the difference was not significant. **Association of diet with weight change:** Nutrient intakes were not significantly associated with difference in weight change between premenopausal and postmenopausal women. **Association of** physical activity **with weight change:** Exercise (METs × hours per week) was not significantly associated with difference in weight change between premenopausal and postmenopausal women. **Association of other factors with weight change: number of births, age at menarche** Higher number of births was significantly associated with weight gain in	**Adjusted for:** Age and weight at baseline and menopausal status at follow-up. **Author's conclusions:** Reproductive factors rather than sociodemographic factors and behavioural factors appeared top be associated with weight change during the perimenopausal period; onset of menopause may diminish weight gain whereas early menarche and

	premenopausal at follow-up: 22.4 (SE 0.15); postmenopausal at follow-up: 22.2 (SE 0.15); years since menopause at follow-up 1–2 years: 22.4 (SE 0.23); ≥3 years: 22.0 (SE 0.21).		premenopausal women, and early age at menarche was significantly associated with weight gain in postmenopausal women. HRT use, smoking status, alcohol consumption were not significantly associated with difference in weight change between premenopausal and postmenopausal women.	high parity showed relationships with weight gain.
Blumel 2001 [524] Prospective cohort 2+ **Aim:** To evaluate the influence of menopause on weight and the effect of weight gain on coronary risk factors	271 Chilean premenopausal women (not receiving HRT) aged between 40 and 53 (mean 45.3) years. **Baseline BMI or weight:** Mean weight and BMI for 40–44-year-olds: 60.9 ± 10.1 kg and 25.3 ± 3.5 kg/m^2, 45–49-year-olds: 63.7 ± 8.6 kg and 26.3 ± 3.8 kg/m^2, 50–54-year-olds: 65.1 ± 9.7 kg and 27.3 ± 4.4 kg/m^2.	**Year of baseline survey:** 1991–92 **Duration of follow-up**: 5 years **Outcome variable**: Weight (kg), BMI. **Self-reported or measured weight:** Measured. **Statistical analysis**: Kruskall–Wallis test, Bartlet test and the χ^2 test.	**Attrition:** 57% **Weight changes:** Women showed a weight gain of 4.0 ± 4.6 kg ($p > 0.0001$) and an increase in the BMI of 1.7 ± 2.4 kg/m^2 (from 25.9 ± 3.8 to 27.6 ± 4.1 kg/m^2, $p > 0.0001$). The percentage of overweight and obese women increased from 54.2% observed in 1991–92 to 70.9% ($p > 0.0001$). The risk of obesity (BMI >30 kg/m^2) by the end of the study depended on the initial BMI: only 1.6% of women with BMI <25 kg/m^2 at baseline were obese at follow up, whereas 28.6% of those who were overweight at baseline were obese at follow-up and 91.4% of those who were obese at follow-up. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change: HRT use** Weight gain was similar in those who did or did not use HRT (non users, 4.3 ± 4.8 kg; users 3.5 ± 3.7 kg, ex-users, 3.4 ± 5.8 kg).	**Adjusted for:** Not reported. **Author's conclusions:** During the perimenopausal period there is a weight gain that does not seem to depend on the menopause.

<table>
<tr>
<td>Wing 1991

Prospective cohort
2+

Healthy Women Study. (two papers).

Three main aims:
1) To describe the weight changes that occurs in a sample of healthy women at time of menopause;

2) To determine whether change in weight is related to change in CHD risk factors during the menopausal period;

3) To identify specific variables associated with weight gain to help determine which individuals are</td>
<td>485 women aged between 42 and 50 years old and menstruated within the past 3 months, had no surgical menopause, a diastolic blood pressure less than 100 mmHg, and not to be taking lipid-lowering drugs, insulin, thyroid medication, estrogens, antihypertensive drugs or psychotropic drugs.

Baseline BMI/weight:
See results table.

Burnette 1998
541 menopausal women from Pittsburgh who were non smokers, ex-smokers or smokers

Baseline BMI or weight:</td>
<td>Year of baseline survey:
1983–84

Duration of follow up:
3–4 years (depending on when baseline measurements were taken for Wing, 2 years for Burnette).

Outcome variable:
Weight (kg, lb) and BMI.

Self-reported or measured weight:
Measured.

Statistical analysis:
Regression analyses (Wing) chi square (Burnette).</td>
<td>Wing 1991

Attrition:
11%

Weight changes:
Women gained a mean of 2.25 kg during follow-up. The SD for weight gain was 4.19 kg with a range from a 14.85 kg loss to a 32.4 kg gain. 20% of the women gained ≥4.5 kg, while only 3% lost ≥4.5 kg.

The table below shows changes in weight, BMI and skinfold thicknesses in premenopausal, perimenopausal and postmenopausal women:

<table>
<tr><th>Measurement</th><th>Premenopausal</th><th>Perimenopausal</th><th>Postmenopausal</th></tr>
<tr><td>Baseline weight (kg)</td><td>64.8 ± 11.9</td><td>67.2 ± 12.6</td><td>68.8 ± 13.9</td></tr>
<tr><td>Change in weight (kg)</td><td>2.1 ± 4.1</td><td>2.5 ± 3.3</td><td>1.4 ± 4.9</td></tr>
<tr><td>BMI at baseline (kg/m^2)</td><td>24.34 ± 4.17</td><td>24.85 ± 4.62</td><td>26.01 ± 5.33</td></tr>
<tr><td>Change in BMI (kg/m^2)</td><td>1.09 ± 1.63</td><td>1.29 ± 1.28</td><td>0.98 ± 1.95</td></tr>
<tr><td>Triceps skinfold thicknesses at entry (mm)</td><td>24.8 ± 7.3</td><td>25.1 ± 7.1</td><td>26.0 ± 7.7</td></tr>
<tr><td>Change in triceps skinfold thicknesses (mm)</td><td>2.9 ± 8.0</td><td>2.6 ± 7.1</td><td>3.2 ± 8.3</td></tr>
</table>

From the table, it is possible to see there were no significant differences in weight gain of women who remained pre menopausal and those who had a natural menopause (2.07 vs. 1.35 kg)

Association of diet with weight change:
No analysis.

Association of physical activity with weight change:
No analysis.

Association of other factors with weight change:
Hormone therapy: Women who took hormone therapy appeared to be greater than that seen in other groups. These women had significant</td>
<td>Adjusted for:
Not reported.

Author's conclusions:

(Wing):
Weight gain is a common occurrence for women at menopause.

Authors' conclusions: (Burnette)
Smoking cessation in perimenopausal to postmenopausal women is associated with greater weight gain but appears to be modestly associated with certain positive changes in cardiovascular risk factors.</td>
</tr>
</table>

at risk of gaining weight at menopause **Burnette 1998** To investigate the relationship between smoking cessation, subsequent weight gain and cardiovascular disease risk factors from premenopause to postmenopause.	Non-smokers mean weight 147.08 ± 27.72 lb (66.7 ± 12.6 kg); all smokers mean weight 143.67 ± 30.51 lb (66.5 ± 13.8 kg). Smokers who continued through second year post menopause mean weight 143.81 ± 30.46 lb (65.2 ± 13.8 kg). Smokers who reported quitting at years 1 and 2 post menopause mean weight 143.09 ± 31.18 lb (64.9 ± 14.1 kg).		increases in weight (p > 0.0001), BMI (*p* > 0.0001), triceps skinfold thickness (*p* > 0.0001) and suprailiac skinfold thickness (*p* > 0.05). *Smoking:* In non-smokers (*n* = 339) the mean weight gain during the 3 years of follow up was 2.12 ± 4.05 kg. Weight gain in women who were premenopausal (*n* = 202) averaged 2.21 kg; in those who were perimenopausal (*n* = 67), weight gain averaged 2.30 kg; in postmenopausal women at follow up (*n* = 33), weight gain averaged 0.63 kg. Women who took hormone therapy (*n* = 20) gained 2.30 kg and those who had never had a hysterectomy (*n* = 17) gained 3.11 kg. Changes over time were significant (*p* > 0.0001), although they did not significantly differ among the various menopausal statuses of women. **Burnette 1998** **Attrition:** 8% **Weight changes:** *First-year post menopause:* significant group effects were found for weight; after-baseline quitters gained significantly more weight (*n* = 28, mean 11.36 lb [5.1 kg]) than non-smokers (*n* = 297, mean 5.32 lb [2.4 kg]) and continuing smokers (*n* = 91, mean 5.45 lb [2.5 kg]). *Second-year post menopause:* after baseline quitters experienced significantly greater weight gain (*n* = 26, mean 14.43 lb [6.5 kg]) than non-smokers (*n* = 265, mean = 7.69 lb [3.5 kg]). **Association of other factors with weight change: smoking** NB: Quitters had significantly greater decrease in alcohol consumption than non-smokers and continuing smokers.	
Crawford 2000 Prospective cohort 2+ Massachusetts Women's Health Study **Aim:**	418 women aged between 50–60 years from MA, USA **Exclusion criteria:** Subjects must have had an intact uterus, at	**Year of baseline survey:** 1986 **Duration of follow-up**: 3 years. **Outcome variable**: Weight (kg) and BMI. **Self-reported or**	**Attrition:** 22.4% **Weight changes**: Mean change in weight between annual consecutive interviews was small, ranging from 0.2 kg to 0.04 kg and was not significantly different from zero at any follow up. The percentage of women with stable weight (annual change of no more than 1 kg) rose from 25.9% at year 1 follow-up and 34.9% at year 3 follow-up. 20.4–25.1% of subjects at an interview were over weight and another 18.2–	**Adjusted for:** Baseline weight. **Author's conclusions:** Menopause transition was not consistently associated with increased weight, exercise

To investigate weight gain linked to the menopause.	least one ovary, and at first contact no more than 11 consecutive months of amenorrhoea. **Baseline BMI or weight:** Mean weight of subjects 72.2 kg, mean BMI 27.6 kg/m^2. 22.6% of subjects overweight (BMI 27.3–32 kg/m^2). 20.2% of subjects obese (BMI >32 kg/m^2).	**measured weight:** ***measured*** **Statistical analysis**: Multivariate linear regression.	21.7% were obese. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** Exercise: change in exercise was significantly related to adjusted log weight (*p* = 0.04), with higher adjusted log weight among women who ceased exercising. **Association of other factors with weight change (please state factors):** *Smoking:* Adjusted weight was higher among women who stopped smoking compared with continuing smokers (*p* = 0.04), although smoking change as a whole was not significant (*p* > 0.05). *Alcohol:* Higher alcohol consumption at a previous contact and a larger increase in ethanol consumption between annual contacts also were marginally significantly related to higher adjusted weight (*p* = 0.07–0.08).	and alcohol were more strongly related to weight than menopause transition.
INDIVIDUAL COHORT STUDIES: PREGNANCY				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
Williamson 1994 Prospective cohort Aim: To examine the effect of childbearing on weight change	2547 white women aged 25-45 years who were initially weighed in the First National Health and Nutrition Examination Survey (NHANES) (n = 3699).	Year of baseline survey: 1971-1975 Duration of follow-up: 10+ years Outcome variable: Measured. Self-reported or measured weight: Measured.	Attrition: 31% Weight changes: Estimated weight gain for women who did not have any live births during the study period (n = 2239) was 3.8 kg. Association of diet with weight change: None reported Association of physical activity with weight change: None reported Association of other factors with weight change: pregnancy	Adjusted for: Duration of follow-up, age, BMI, initial parity, education, and other lifestyle behaviours. Author's conclusions: Generally the risk of weight

		Statistical analysis: Linear and logistic regression	Compared to parous women who did not give birth during the study period, the mean excess weight gain was 1.6 kg (95 Confidence Limits, +/- 2.3 kg) for nulliparous women, and was 1.7 kg (+/- 1.1 kg), 1.7 kg (+/- 2.0 kg), and 2.2 kg (+/- 4.3 kg), for women having one, two and three live births, respectively. Among women who were nulliparous at baseline, those that had their live births during the study period gained similar amounts of weight to that of women who began childbearing before the beginning of the study. The risk of gaining more than 13 kg was increased by 60% for women having one live birth and by 40%for women with two live births. The risk of becoming overweight (BMI >27.3) was increased by 60% and risk of becoming severely overweight (BMI>30) was 110% in women having live births during the study.	gain was modest, but for some women the risks of major weight gain and becoming overweight were increased in association with childbearing.
Wolfe 1997 **Design:** Prospective cohort NHANES 1 (1971–75) and NHEFS (1982–84) **Aim:** To examine how the relationship between parity increase and weight gain is modified by socio-demographic and behavioural factors.	2952 adults (2534 White women and 418 African American women) aged 25–45 years residing in the contiguous 48 US states participated in NHANES 1 and were systematically followed up in the NHEFS. Mean baseline weight for White women = 64.3 kg. Mean baseline weight for African American women = 71.3 kg.	**Year of baseline examination and questionnaire:** 1971–75 **Duration of follow-up:** Approximately 10 years. **Outcome variable:** Parity associated weight gain. **Self-reported or measured weight:** Measured within a personal interview and medical examination. **Statistical analysis:** Multiple linear regression analysis Eight socio-demographic covariates and their interactions with parity	**Attrition:** Not mentioned **Weight changes:** Weight gain from baseline to follow-up averaged 4.4 kg for White women and 5.5 kg for African American women. Among White women, after adjusting for baseline parity and other socio-demographic variables, the weight gain for non-employed married metropolitan women averaged 4.2 kg for those with no change in parity, compare with 4.7 kg for those with a parity increase of one child and 7.4 kg for those with a parity increase of two or more children. Among African American women, adjusted for the same variables, weight gain for those with no change in parity averaged 4.9 kg, compared with 7.2 kg for those with a parity increase of one or more. The probability of substantial weight gain (more than 11.4 kg) also rose with parity increase. White women with a parity increase of two or more were also twice as likely to experience substantial weight gain as those with no change in parity. However the probability increased only slightly for those with a parity increase of just one. Among African American women, those with an increase in parity were about five times as likely to experience substantial weight gain as those with no parity increase.	**Adjusted for:** Baseline height, the square of the subject's age to adjust for the curvilinearity of the relationship between body weight and age, and the number of years between the baseline and follow-up measurements as a control for the duration of opportunity for weight change. **Author's conclusions:** The effects of socio-demographic and behavioural factors on

		change in relation to weight gain were examined, these included; baseline weight, baseline parity, baseline age, employment status at baseline, marital status at baseline, rural versus metropolitan residence, family income at baseline and educational level at baseline. Three behavioural variables and their interactions with parity change in relation to weight gain were examined. These included cigarette smoking, recreational exercise and non-recreational PA.	For Whites, a parity increase of two or more was associated with greater weight gain in women with higher baseline weight compare with those with lower baseline weight, in non-employed compare with employed women and in non-married compare with married women. Smoking also interacted with parity increase in its effect on weight gain in White women, but with mixed results. Among women with a parity increase of two or more, smokers gained less additional weight (when compare with women with no parity increase) than non-smokers, but among women with a parity increase of just one, smokers gained much more additional weight. Among African American women, a parity increase of one or more was associated with greater weight gain in women with lower baseline weight, in those with lower incomes and in non-smokers. Smokers in this group not only gained less than non-smokers, but they also gained far less than smokers with non-parity increase. Among White women, being not employed, unmarried, in a rural residence, with lower educational attainment, having fewer children at baseline and having a higher level of non-recreational PA at baseline, all increased the probability of gaining more than 11.4 kg given an increase in parity of two or more. Younger age increased the probability given an increase in parity of one. Among African Americans, the effect of a parity increase of one or more on the probability of gaining >11.4 kg was similar to a parity increase of two or more among Whites. Those with lower educational attainment and fewer children at baseline were more likely to have a substantial weight gain. Older women were more likely to experience substantial weight gain with an increase in parity then were their younger counterparts.	parity-associated weight gain varied by race and parity change, with the most consistent findings being that unmarried and unemployed White women had greater parity associated weight gain, while both White and African American women who smoked, had higher education, or higher parity had lower parity associated weight gain.
Sowers 1998 **Aim:** To compare the weight changes in lactating women within an 18-month inter-	The 25 cases and 20 controls were recruited from a parent population comprised of 115 women, aged 20–40 years and 0–1 parity, who	**Year of baseline examination and survey:** Not stated. **Duration of follow-up:** Evaluation included six measurements in the postpartum period at	**Attrition:** 100% – no dropouts **Weight change:** The average weight loss in the postpartum period was 4.7 kg for cases and 4.4 kg for controls, which was not significantly different. There was no statistically significant difference between the weight retention patterns of all the women. The average weight retention curve for the cases and controls had similar shapes, initially they declined and then	**Adjusted for:** Energy intake, energy expenditure and weight gain during the subsequent gestational period.

pregnancy interval with women who also breastfed but did not have an immediate subsequent pregnancy.	were enrolled in a previous bone mass and lactation study. Cases were women who breastfed an index infant for 6-months and subsequently became pregnant within 18-months. Controls were women who also breastfed an index infant for 6-months but had no ensuing pregnancy within 18 months. Mean age = 29.3 years. Mean BMI prior to pregnancy = 22.2 (range, 16.9 – 33.8) kg/m^2. Mean weight prior to pregnancy = 59.7 (range, 43– 93) kg.	0.5, 2, 4, 6, 12 and 18 months. The 25 cases did not continue with the scheduled measurement intervals; instead these women were measured for the final time within 14 days of their subsequent delivery. **Outcome variables:** 1) Postpartum weight retention – calculated by subtracting weight prior to the pregnancy of the reference infant from weight at each evaluation point during the postpartum period. 2) Across pregnancy weight difference, which was the difference between the weight of the cases 2 weeks after the birth of the reference infant and 2 weeks following the birth of the subsequent infant. **Self-reported or measured:** Measured. **Statistical analysis:** *t* tests were used to assess the comparability of the	began to plateau at about 8–10 months postpartum. Among the cases, post pregnancy weight following the baseline pregnancy was compared with post pregnancy weight following the subsequent pregnancy. On average, cases weighed 1.3 kg more after the subsequent pregnancy than they weighed following the baseline pregnancy. At their final measurement, controls weight 4.59 kg less than their post-pregnancy baseline. **Association of diet and physical activity with weight change:** Not a great deal mentioned other than, estimates of energy intake and/or PA were not important factors in explaining the weight differential between the baseline postpartum weight and the subsequent postpartum weight. **Association of other factors with weight change:** No other factors were considered.	**Author's conclusions:** Data suggest that there is no evidence that women with an inter-pregnancy interval <18 months have a different weight retention pattern than other women who delay a subsequent conception >24 months. **Comments:** Subtle differences in weight retention patterns between cases and controls would have been difficult to observe because of the sample size. Participants in this study were White, non-smokers with high education levels who may have had a different inter pregnancy interval

		controls with the cases. Paired *t* tests were used to assess the change in weight between the baseline post parturition measure and the subsequent postpartum measure among the cases. Simple linear regression analysis was used to describe any factors that might explain the weight changes between the beginning of the initial or baseline postpartum period and subsequent postpartum measure. The comparison of weight retention patterns for the cases and the controls was evaluated by longitudinal analysis using non-parametric mixed models.		experience than women from more diverse populations.
Linne 2003 Prospective cohort 2+ **Aim:** To examine long-term	1423 Women in Stockholm who delivered children in 1984–85. **Pre-pregnant mean weight:** 59.5 (8.1) kg;	**Year of baseline survey:** 1985 **Duration of follow-up**: 15 years. **Outcome variable**: Change in weight and	**Attrition:** 61% (*n* = 1423) of women eligible (*n* = 2342) completed initial questionnaire and 40% (*n* = 563) participated in 15-year follow-up questionnaire. **Weight changes:** Mean weight increase during pregnancy was 14.1 kg (4.1); 1-year after delivery mean weight increase was 1.5 kg, when corrected for underreporting and general phenomenon of weight increase over time the net mean weight increase induced by pregnancy was 0.5 kg, but range was	Women who participated in the 15-year follow-up had higher income and higher educational attainment than non-responders

weight development after pregnancy. The Stockholm Pregnancy and Women's Nutrition Study – SPAWN Also Ohlin 1994, 1996; Rossner 1995; Linne 2002.	pre-pregnant BMI: 21.5 (2.8) kg/m^2.	BMI. **Self-reported or measured weight:** Self-report and retrospective until after birth then prospective and measured (200 of 563 self-reported weight at 15 years). **Statistical analysis**: *t* test and χ^2 test.	very wide and 1.5% women had retained at least 10 kg. Over 15 years the initially normal weight group increased BMI from 20.7 to 22.3 kg/m^2 and the overweight group (BMI >25 kg/m^2 at 15 years) increased from 23.3 to 28.6 kg/m^2 (t = 0.342, df = 548, p > 0.0001); (women who were overweight at both time points [n = 33] and those who lost weight and regained a BMI in the normal range at 15 years [n = 10] were excluded from analysis). Women who became overweight had a higher pre-pregnant BMI (p > 0.001) and gained more weight during pregnancy (p > 0.001). **Association of diet with weight change:** Women that started to eat more irregularly retained more weight at 1-year postpartum. **Association of physical activity with weight change:** Women that started to exercise less frequently after their pregnancies retained more weight 1-year postpartum. **Association of other factors with weight change: pregnancy** Most important risk factor identified for sustained weight gain/retention 1 year after delivery was weight increase during pregnancy (large variances in weight meant any statistically significant relationships were rather weak at 1-year post delivery so other 1-year results not reported here); No difference between women who became overweight and those who remained normal weight regarding total number of children, number of pregnancies before and after index pregnancy, age at index pregnancy, age at delivery of first child. Features of pregnancy that did not differ between the two groups were total gestational duration, type of delivery, sex and birth weight of child, city of residence, breastfeeding and smoking cessation. Women who became overweight had lower lactation scores (p > 0.05); relatively more subjects of the group that became overweight stopped smoking during pregnancy (p > 0.01).	and national average. No control group of women without children. Impossible to determine if 15-year data represent a linear development over time as not seen since 1-year postpartum. **Author's conclusions:** Pregnancy is a vulnerability factor for some women to become overweight, demographic, behavioural, physical and psychological factors only partly explain the weight gain observed at 15-years follow-up
Olsen 2003 Prospective	622 healthy adult women who gave birth	**Year of baseline survey:** Not reported.	**Attrition:** n/a as analysed completer sample **Weight changes:**	Factors related to excessive gestational

cohort 2+ **Aim:** To evaluate whether potentially modifiable psychological and behavioural factors are related to gestational weight gain and whether the same factors relate to both excessive and insufficient weight gain.	to live singleton infants in a 10-county area of upstate New York, 96% White, rural and socio-economically diverse **Baseline BMI: not stated, mean gestational weight gain: 29.7lb**	**Duration of follow-up**: From early pregnancy until 2 years postpartum. **Outcome variable**: Weight change. **Self-reported or measured weight:** Measured. **Statistical analysis**: Multiple linear and logistic regression with adjustment for timing of measurements and length of gestation.	Mean gestational weight gain = 29.7 (11.7) lb (13.5 [5.3 kg]); high-BMI women were five times more likely than normal BMI women to exceed the top of the range of the Institute of Medicine guidelines. **Association of diet with weight change:** Women who reported eating much more food in pregnancy were 2.35 times more likely than women who ate a little more to gain excessive weight. **Association of physical activity with weight change:** Less PA (OR 1.68; 95% CI 1.1, 2.6) was significantly related to excessive gestational weight gain. **Association of other factors with weight change (please state factors):** Family income of less than 185% of the federal poverty line (OR 2.59; 95% CI 1.6, 4.2) was significantly related to excessive gestational weight gain. Income was not as important an influence on gestational weight gain among women who reported that they increased their food intake (OR 0.33).	weight gain only are reported here. **Adjusted for:** Not clear. **Author's conclusions:** Food intake, PA and smoking accounted for 27% variance in gestational weight gain.
Rosenberg 2003 Prospective cohort 2+ **Aim:** To evaluate the effect of childbearing on weight gain in African American women Participants in Black Women's Health Study.	11,196 African American women parous and nulliparous at baseline who had a singleton birth in 1995 to 1997 and none in 1997 to 1999 or nulliparous from 1995–99 and did not report occurrence of cancer; 9966 remained nulliparous, 598 had first child, 387 primiparous women had	**Year of baseline survey:** 1995 **Duration of follow-up**: 4 years. **Outcome variable**: Weight gain (kg). **Self-reported or measured weight:** Self-report. **Statistical analysis**: Multivariate linear regression (women who remained nulliparous served as comparison group).	**Attrition:** unclear **Weight changes:** BMI increased by 1.6, from 26.5 to 28.1 kg/m^2, equivalent to weight gain 4.4kg BMI 23 kg/m^2 in 1995, BMI change: nulliparous = 1.7, parity 1 = 1.9, parity 2 = 1.8, parity 3+ = 1.8 kg/m^2 BMI 36 kg/m^2 in 1995, BMI change: nulliparous = 1.3, parity 1 = 2.4, parity 2 = 2.1, parity 3+ = 2.1 kg/m^2 **Association of other factors with weight change: parity** Women who had a child during follow-up gained more weight than women who remained nulliparous, and those who had a first child gained more than those who had a second or later child, weight gain associated with childbearing increased with increasing baseline BMI and was appreciable among heavier women	**Adjusted for:** Predicted values of BMI change between 1995 and 1999 for parous and nulliparous women with selected characteristics (25–29 years at baseline, age at menarche 12–13 years, 16 years of education, non-smoker, single, BMI 20–24 kg/m^2 at age

	second child, 245 had third or later child **Baseline BMI: 26.5 kg/m^2**			18, 1–4 hours vigorous activity per week, 1–4 hours TV/videos per day, non-use hormonal contraception, no medication-treated depression. **Author's conclusions: childbearing is an important contributor to weight gain among African-American women.**
CARDIA (Coronary Artery Risk Development in Young Adults) Prospective cohort 2+ **Aim:** To estimate the change in BMI over 10 years in a cohort of young US men and women, and assess differences by a range of	CARDIA is a population based prospective study of 5,115 African American and White men and women in USA aged 18–30 year at baseline. Study population was balanced on: Age (45% 18–24 years) Sex (46% men) Ethnicity (52% African	**Year of baseline survey:** 1985–86 **Duration of follow-up**: Ongoing. **Outcome variable**: Measured. **Statistical analysis**: Various, but all used some form of regression analysis. Women who remained nulliparous (*n* = 925) at 5 years were compared with women who had a single pregnancy and who	**Attrition:** Baseline data were collected on 51% of eligible persons contacted. Overall retention rates were 90% at 2 years, 86% at 5 years, 81% at 7 years, 79% at 10 years, and 74% at 15 years. **Association of other factors with weight change: Pregnancy** **Pregnancy (based on 5-year follow-up of 2788 women at baseline):** Primiparous within both race groups gained 2 or 3 kg more weight during the 5-year period than did nulliparous. Primiparous also had greater increases in waist-to-hip ratio that were independent of weight gain. Multipara did not differ from nulliparous in adiposity change in either race group. **Pregnancy – Black and Minority Ethnic Groups:** At each level of parity, Black women demonstrated greater adverse changes in adiposity than did White women. **Conclusion:** Women experience modest but adverse increases in body weight and fat distribution after a first pregnancy and that these changes are persistent.	All analyses were **adjusted for** covariates: Age Education Smoking status Also adjusted for PA in analysis. Overweight was defined as BMI >25.0 kg/m^2.

variables. Smith 1994 (Pregnancy – based on 5-year follow-up.)	American). No data on income presented in this paper. **Baseline weight (kg) as mean (SD) and overweight (%):** African American women: 69.5 (18.3) kg, 44.7% White women: 63.1 (12.8) kg, 22.1% African American men: 77.5 (15.6) kg, 36.9% White men: 77.1 (12.6) kg, 12.6%.	were at least 12 months postpartum at 5 years.		

INDIVIDUAL STUDIES: SMOKING CESSATION				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
Williamson (1991) Prospective cohort 2+ **Aim:**	A population sample of US adults who entered NHANES I at ages 25–74 years. Continuing	**Year of baseline survey:** 1971–75 **Duration of follow-up**: About 10 years – follow-up 1982–84.	**Attrition:** Unclear. 9332 of the original 14,407 participants took part in the NHANES 10-year follow-up (attrition of 35%). (But remember that only a sub-sample of this cohort is the subject of this analysis – only continuing smokers and sustained quitters – sample size 2653.) **Mean BMI changes:** Not reported for overall sample.	**Confounders adjusted for:** Age, race, level of education, alcohol use, illnesses related to change in weight, baseline

To evaluate associations between smoking cessation and weight change.

smokers (748 men, 1137 women) and sustained quitters (those who had quit smoking for a year or more – 409 men and 359 women).

Baseline BMI (kg/m^2):
Continuing smokers:
Men: 25.1
Women: 24.0
Sustained quitters:
Men: 25.7
Women: 24.5

Outcome variable:
Weight change as a continuous variable and as a categorical variable:
1) Gained 0.0–3.0 kg
2) Gained 3.1–8.0 kg
3) Gained 8.1–13.0 kg
4) Gained 13.1 kg+

Self-reported or measured weight:
Measured.

Statistical analysis:
When BMI change considered as a *continuous* variable: multiple linear regression models. When BMI change considered as a *categorical* variable: multivariate logistic regression models.

Association of other factors with weight changes:
1) Mean weight gain attributable to smoking variable (kg) – adjusted for the confounders listed in next column.

	Continuing smokers	Sustained quitters	Difference* (95% CI)
Men	0.3	3.1	**2.8** (2.0, 3.6)
Women	1.7	5.5	**3.8** (2.9, 4.7)

*Both significantly ($p > 0.05$) greater than 0.0 kg.

2) Smoking and level of weight gain (kg)

a) Percentages (i.e. unadjusted).

	Continuing smokers	Sustained quitters
Men		
0.0–3.0 kg	65.1	55.8
3.1–8.0 kg	23.9	22.0
8.1–13.0 kg	8.4	12.5
>13.1 kg	2.5	9.8
Women		
0.0–3.0 kg	62.3	48.5
3.1–8.0 kg	23.5	26.7
8.1–13.0 kg	9.3	11.4
>13.1 kg	4.9	13.4

b) Adjusted OR (sustained quitters vs. continuing smokers, all significantly ($p > 0.05$) greater than 1.0).

	Weight gain (kg)		
	3.1–8.0	8.1–13.0	>13.1
Men	1.4	2.6	8.1
Women	2.1	2.5	5.8

weight and PA.

Author's conclusions:
Major weight gain is strongly related to smoking cessation, but occurs in only a minority of those who stop smoking. (The authors note that weight gain is not likely to negate the health benefits of smoking cessation, but may interfere with attempts to quit for cosmetic reasons.)

			Among sustained quitters, factors significantly related to higher odds of major weight gain were: • Being Black (compared with White); • Being underweight at baseline (compared with normal weight, women only – BMI ranges used not stated); • Having smoked >25 cigarettes per day (compared with <15); • *Lower* recreational PA in men; • Higher recreational PA in women; • Being 25–54 years old at baseline (compared with 55–74 years); • Having had one or more live births (compared with none, women). **Summary of results:** Those who have quit smoking for >1 year experienced a greater mean weight gain and were more likely to experience major weight gain than continuing smokers. By the end of the study, however, the mean body weight of those who had quit increased only to that of those who had never smoked.	
Burke 2000 Prospective cohort 2+ **Aim:** To examine the influence of smoking cessation on weight gain in MA.	1930 MA and 1126 NHW aged between 25–64 years of age from low, middle and high-income neighbourhoods in San Antonio, TX, USA. **Baseline BMI or weight:** MA males never smoked (*n* = 457) BMI = 27.8 kg/m^2, quitters (*n* = 102) BMI = 28.5 kg/m^2, continuous smokers (*n* = 178) BMI =	**Year of baseline survey:** 1979 **Duration of follow-up**: 9 years. **Outcome variable**: Weight (kg), BMI. **Self-reported or measured weight:** Measured. **Statistical analysis**: Linear regression.	**Attrition:** MA 42%, NHW 40% **Weight changes:** As a result of smoking cessation, a total of 342 became overweight during follow up (had a BMI <25 kg/m^2 at baseline and a BMI ≥25 and <30 kg/m^2 at follow-up). Of those, 18 (5.3%) were estimated to be attributed to smoking cessation. For MA, 13 of the 196 (6.6%) were estimated to be attributed to smoking cessation. For NHW, 5 of the 146 (3.4%) were estimated to be attributed to smoking cessation ($p > 0.05$). 331 individuals became obese during follow up (BMI <30 kg/m^2 at follow-up); 18 were attributed to smoking cessation. For MA, 12 of 219 (5.5%) were attributed to smoking cessation; for NHW, 6 of the 112 (5.4%) were estimated to be attributed to smoking cessation ($p > 0.05$). A total of 377 individuals became overweight or obese during follow-up (had a BMI <25 kg/m^2 at baseline and BMI ≥25 kg/m^2 at follow-up). Of the 377 21 (5.6%) were attributed to smoking cessation. For MA, 16 of the 216 (7.4%) were estimated to be attributed to smoking cessation, for NHW 5 of the 161 (3.1%) were estimated to be attributed to smoking cessation. This ethnic difference was borderline statistically significant ($p = 0.072$).	**Adjusted for:** Not reported. **Author's conclusions:** There is an ethnic difference in the influence of smoking cessation on weight gain in MA and NHW. Although, in both ethnic groups this effect is quite small and makes only a slight difference and only makes a slight contribution to

	27.5 kg/m^2. MA females never smoked (*n* = 457) BMI = 27.7 kg/m^2, quitters (*n* = 102) BMI = 27.0 kg/m^2, continuous smokers (*n* = 178) BMI = 27.2 kg/m^2 NHW males never smoked (*n* = 457) BMI = 26.8, quitters (*n* = 102) BMI = 25.5 kg/m^2, continuous smokers (*n* = 178) BMI = 26.4 kg/m^2. NHW females never smoked (*n* = 457) BMI = 24.7 kg/m^2, quitters (*n* = 102) BMI = 23.7 kg/m^2, continuous smokers (*n* = 178) BMI = 24.2 kg/m^2.		**Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** Smoking Overall, the estimated risk of becoming overweight or obese attributable to smoking cessation was only 7.4 % in MA and 3.1% in NHW.	the overall increase in prevalence of obesity in the cohort.
The Israeli CORDIS II study	3816 (68.8%) of male employees working in 21 factories in Israel were	**Year of baseline survey:** 1985–87 **Duration of follow-up**: 1988–90. Average	**Attrition:** Difficult to assess. At follow-up in 1988–90 (CORDIS II) only 1338 could be re-examined (many had been made redundant in the interim). Of these, 129 were excluded (missing data), thus *n* = 1209.	Data are presented here only for two groups: QSAE and CS, since

Prospective cohort 2+ **Aim:** To quantify the risk of weight gain after cessation of smoking, the duration of the risk, and the effect of possible moderating variables. **NS**: never smoked **QSBE**: quit smoking before entry to study **QSAE**: quit smoking after entry to study **CS**: current smokers	offered free screening examinations for selected risk factors 1985–87. 68% (*n* = 3816) agreed. These were then subdivided into four groups; NS, QSBE, QSAE, CS. ALL baseline data as mean (SE). QSAE: *n* = 65 CS: *n* = 392 **Age:** QSAE: 40.7 (10.3) years CS: 42.7 (10.9) years **Ethnicity**: (father born in North Africa, Iraq, Iran, Yemen): QSAE: 46.1% CS: 47.4% **Education** (reporting >12 years of education): QSAE: 49.2% CS: 61.0%	follow-up = 2.6 (range 2–4) years. **Outcome variable**: BMI . **Self-reported or measured weight:** Measured. **Statistical analysis**: Multivariate analysis was used to determine the predictive power of a model consisting of all independent variables (smoking status, age, sports activity, education, alcohol consumption, ethnicity, duration of follow-up and BMI at entry) to predict the increase in BMI over the follow-up period.	**Weight changes:** During follow-up, the mean age-adjusted increase in BMI was 0.99 kg/m^2 among QSAE and 0.24 kg/m^2 among CS. QSAE gained weight regardless of age; CS gained less weight with increasing age, and none gained weight after 50 years of age. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** Sports activity was negatively associated with gain in BMI during follow-up. **Association of other factors with weight change:Smoking** No significant interactions were found between **smoking** status and any other variable. Cessation of smoking after entry to study (QSAE) was positively related to an increase in BMI, whereas age, initial BMI, alcohol consumption were negatively associated with gain in BMI during follow-up. Cessation of smoking after entry, age, BMI at entry, and sports activity explained 8.7% of the variance in increase in BMI during follow-up. Further analysis of the QSBE group suggested that the increased rate of weight gain after smoking cessation is transient. However, the weight gained is retained for at least 6 years.	this is most meaningful comparison for this review, i.e. 'what happens when people give up smoking compared with those who do not quit'. **Adjusted for**: All variables included in the model. **Authors' conclusions:** The increased gain of weight gain after smoking cessation is transient. However, the weight gained is retained for at least 6 years.

<table>
<tr>
<td></td>
<td>Exclusion criteria:
None.

Baseline BMI:
QSAE: 25.3 (4.0) kg/m^2
CS: 25.4 (3.8) kg/m^2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing 1991

Prospective cohort
2+

Healthy Women Study. (two papers).

Three main aims:
1) To describe the weight changes that occurs in a sample of healthy women at time of menopause;

2) To determine whether change in weight is related to change in coronary heart disease risk factors during</td>
<td>Wing 1991
485 women aged between 42 and 50 years old and menstruated within the past 3 months, had no surgical menopause, a diastolic blood pressure less than 100 mmHg, and not to be taking lipid-lowering drugs, insulin, thyroid medication, estrogens, antihypertensive drugs or psychotropic drugs.

Baseline BMI/weight:
See results table.

Burnette 1998</td>
<td>Year of baseline survey:
1983–84

Duration of follow up:
3–4 years (depending on when baseline measurements were taken for Wing, 2 years for Burnette).

Outcome variable:
Weight (kg, lb) and BMI.

Self-reported or measured weight:
Measured.

Statistical analysis:
Regression analyses (Wing) chi square (Burnette).</td>
<td>Wing 1991
Attrition:
11%

Weight changes:
Women gained a mean of 2.25 kg during follow up. The SD for weight gain was 4.19 kg with a range from a 14.85 kg loss to a 32.4 kg gain. 20% of the women gained ≥4.5 kg, while only 3% lost ≥4.5 kg.

The table below shows changes in weight, BMI and skinfold thicknesses in premenopausal, perimenopausal and postmenopausal women:

<table>
<tr><th>Measurement</th><th>Premenopausal</th><th>Perimenopausal</th><th>Postmenopausal</th></tr>
<tr><td>Baseline weight (kg)</td><td>64.8 ± 11.9</td><td>67.2 ± 12.6</td><td>68.8 ± 13.9</td></tr>
<tr><td>Change in weight (kg)</td><td>2.1 ± 4.1</td><td>2.5 ± 3.3</td><td>1.4 ± 4.9</td></tr>
<tr><td>BMI at baseline (kg/m^2)</td><td>24.34 ± 4.17</td><td>24.85 ± 4.62</td><td>26.01 ± 5.33</td></tr>
<tr><td>Change in BMI (kg/m^2)</td><td>1.09 ± 1.63</td><td>1.29 ± 1.28</td><td>0.98 ± 1.95</td></tr>
<tr><td>Triceps skinfold thickness at entry (mm)</td><td>24.8 ± 7.3</td><td>25.1 ± 7.1</td><td>26.0 ± 7.7</td></tr>
<tr><td>Change in triceps skinfold thickness (mm)</td><td>2.9 ± 8.0</td><td>2.6 ± 7.1</td><td>3.2 ± 8.3</td></tr>
</table>

From the table, it is possible to see there were no significant differences in weight gain of women who remained pre menopausal and those who had a natural menopause (2.07 vs. 1.35 kg).

Association of diet with weight change:
No analysis.</td>
<td>Adjusted for:
Not reported.

Author’s conclusions (Wing):
Weight gain is a common occurrence for women at menopause.

Author’s conclusions: (Burnette)
Smoking cessation in perimenopausal to postmenopausal women is associated with greater weight gain but appears to be modestly associated with certain positive changes in cardiovascular risk factors.</td>
</tr>
</table>

the menopausal period; 3) To identify specific variables associated with weight gain to help determine which individuals are at risk of gaining weight at menopause. **Burnette 1998** **Aim:** To investigate the relationship between smoking cessation, subsequent weight gain and cardiovascular disease risk factors from pre-menopause to post-menopause.	541 menopausal women from Pittsburgh who were non smokers, ex-smokers or smokers. **Baseline BMI or weight:** Non-smokers mean weight 147.08 ± 27.72 lb (66.7 ± 12.6 kg); all smokers mean weight 143.67 ± 30.51 lb (65.1 ± 13.8 kg); smokers who continued through second year post-menopause mean weight 143.81 ± 30.46 lb (65.2 ± 13.8 kg); smokers who reported quitting at years 1 and 2 post-menopause mean weight 143.09 ± 31.18 lb (65.3 ± 14.1 kg).		**Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** *Hormone therapy:* Women who took hormone therapy appeared to be greater than that seen in other groups. These women had significant increases in weight (*p* > 0.0001), BMI (*p* > 0.0001), triceps skinfold thickness (*p* > 0.0001) and suprailiac skinfold thickness (*p* > 0.05). *Smoking:* In non-smokers (*n* = 339) the mean weight gain during the 3 years of follow up was 2.12 ± 4.05 kg. Weight gain in women who were premenopausal (*n* = 202) averaged 2.21 kg; in those who were perimenopausal (*n* = 67), weight gain averaged 2.30 kg; in postmenopausal women at follow-up (*n* = 33), weight gain averaged 0.63 kg. Women who took hormone therapy (*n* = 20) gained 2.30 kg and those who had never had a hysterectomy (*n* = 17) gained 3.11 kg. Changes over time were significant (*p* > 0.0001), although they did not significantly differ among the various menopausal statuses of women. **Burnette 1998** **Attrition:** 8% **Weight changes:** *First year post-menopause:* Significant group effects were found for weight; after-baseline quitters gained significantly more weight (*n* = 28, mean 11.36 lb [5.2 kg]) than non-smokers (*n* = 297, mean 5.32 lb [2.4 kg]) and continuing smokers (*n* = 91, mean 5.45 lb [2.5 kg]). *Second-year post-menopause*: After baseline quitters experienced significantly greater weight gain (*n* = 26, mean 14.43 lb [6.5 kg]) than non-smokers (*n* = 265, mean = 7.69 lb [3.5 kg]). **Association of other factors with weight change: Smoking** NB: Quitters had significantly greater decrease in alcohol consumption than non-smokers and continuing smokers.	
Kawachi 1996	121,700 US women aged	**Year of baseline survey:**	**Attrition:** 15,197 of 24,503 women excluded due to incomplete data leaving 9306	**Adjusted for:** Adjusted

Prospective cohort 2+ **Aim:** To examine whether exercise can modify weight gain after smoking cessation in women. Nurses Health Study (evaluated every 2 years since 1976).	40–75 years (excluded women with history of myocardial infarction, stroke, diabetes, cancer, or who were pregnant or reported extreme levels of exercise). **Baseline BMI: 64-67kg** **Weight**: 64.1–67.3 kg.	1986 **Duration of follow-up**: 2 years. **Outcome variable**: Weight change (kg). **Self-reported or measured weight;** Self-report. **Statistical analysis:** Multiple linear regression to assess impact of PA on post cessation weight gain (excluded 198 women who quit smoking and reduced level of exercise plus 2684 women who continued smoking but change their exercise habits).	analysed; 1474 of 9306 women (15.8%) stopped smoking 1986–88. **Weight changes:** Excess 2.4 kg weight gain associated with smoking cessation. **Association of diet with weight change:** Neither baseline total energy intake nor energy-adjusted fat intake predicted baseline weight or weight change. **Association of physical activity with weight change:** Values are for hypothetical women with same average characteristics as cohort (52 years, 1.6 m high, total daily energy intake 1740 kcals) compared with women who continued smoking without altering their exercise habits (*n* = 5148). No change in PA *n* = 898 smoking 1–24 cigarettes per day in 1986 = 2.3 kg (95% CI 1.9, 2.6) 25 cigarettes per day or more = 4.5 kg (95% CI 3.9, 5.2). Increase by 8–16 METs per week, *n* = 169 smoking 1–24 cigarettes per day in 1986 = 1.8 kg (95% CI 1.0, 2.5) 25 cigarettes per day or more = 3.9 kg (95% CI 2.5, 5.3) Increase by >16 METs per week, *n* = 2091 smoking 24 cigarettes per day in 1986 = 1.3 kg (95% CI 0.7, 1.9) 25 cigarettes per day or more = 2.9 kg (95% CI 1.5, 4.3)	increase in weight from 1986–88 among women who stopped smoking, by level of smoking in 1986 and change in PA between 1986–88 adjusted for age, height, baseline weight, weight change during 2 years before baseline, baseline total energy intake, energy-adjusted baseline fat and alcohol intake, personal history of hypertension of high serum cholesterol. **Author's conclusions:** Weight gain is minimised if smoking cessation is accompanied with moderate increase in levels of PA.
Swan 1995 Prospective cohort 2+	Men from the National Academy of Sciences – National	**Year of baseline survey:** 1967–69 **Duration of follow-up**:	**Attrition:** Non-response rate: 22% at baseline; 34% at follow-up. **1) Effect of smoking category on weight change**	The authors report only unadjusted values, as overall results

Aim: To determine characteristics of individuals that were predictive of excessive weight gain after smoking cessation.	Research Council Twin Registry, USA – recruited into the armed forces during World War II. *n* (total) = 6593 *n* (quitters subsample) = 2 179 Also included subsample of 146 monozygote twin pairs and 111 dizygote twin pairs. Mean age 46.3 years at baseline. **Baseline BMI:** Mean 24.7 kg/m^2.	16 years. **Outcome variable**: Mean weight change (kg) and weight loss category. Weight loss = lost >2.3 kg. Stable weight = gained or lost 2.3 kg or less. Weight gain = +2.4 to +11.2 kg. Excessive weight gain = +11.3 kg or more. **Self-reported or measured weight:** Self-reported. **Statistical analysis**: Analysis of variance unless otherwise stated. Twin concordance rate defined as *C/(C+D)* where *C* is the number of pairs concordant for weight change (i.e. in the same category) and *D* is the number of discordant pairs. Difference between monozygote and dizygote concordance rate tested by a one-sided *z* test of the proportions.	(see results below)	did not change with adjustment for age, SES and baseline weight. **Author's conclusions:** Super-gainers differ in important ways from those who do not gain weight after smoking cessation. These weight changes may be partly influenced by genetic factors.

a) **as a continuous variable** (*p* value not stated)

Smoking category	***n***	**Mean (SD) weight change (kg)**
Quitters	2179	+3.5 (6.9)
Continuing smokers	1569	+0.9 (6.8)
Continuing non-smokers	2751	+1.1 (5.7)
New smokers	94	Not reported

b) **as a categorical variable** (%) (chi-squared *p* > 0.001)

Smoking category	**Weight loss**	**Stable weight**	**Weight gain**	**Excessive weight gain**
Quitters	15	33	39	13
Continuing smokers	21	45	30	4
Continuing non-smokers	23	42	29	6

2) Analysis of quitters: comparison of super-gainers and stable weight group

a) at baseline

Super-gainers:
- Were slightly younger (45.9 vs. 46.5 years);
- Were of lower SES (rank 66.2 vs. 71.2);
- Started smoking at a younger age (17.6 vs. 18.7 years);
- Were heavier smokers (26.6 vs. 23.0 cigarettes per day);
- Were slightly less physically active (rank 3.3 vs. 3.7);
- Drank more coffee (4.3 vs. 3.8 cups per day);
- And ate slightly fewer pastries (1.5 vs. 1.6 per day).

At baseline than those in the stable weight category (*p* > 0.05).

No significant effects for:
- BMI at age 25 years;
- BMI at baseline;
- alcohol consumption;

			• frequency of candy per day; • dieting. **b) at follow-up** Super-gainers were more likely: • to be single (15 vs. 10%) • to report having to diet to keep weight low (53 vs. 28%) at follow-up than those in the stable weight category ($p > 0.05$). No significant effects for retirement status or presence of cardiovascular disease. **c) changes in behaviours from baseline** Super-gainers: • reported a smaller increase in wine consumption (3.3 vs. 6.2 drinks per month) but a larger increase in liquor consumption (15.2 vs. 7.9 drinks per month) • reported a larger increase in candy consumption (0.1 vs. 0.0 pieces per day) from baseline to follow-up than those in the stable weight category ($p > 0.05$). No significant effects for change in beer, coffee or pastry consumption. **3) Twin concordance for weight change amongst quitters** Concordance rates for weight gain were 53% for monozygote twins and 38% for dizygote twins (p for difference <0.05). Concordance rates for weight loss were 46% (monozygote) and 27% (dizygote) (p for difference <0.05). **Summary of results:** • Quitters were more likely to experience weight gain of 2.3 kg or more, and less likely to experience weight loss, than continuing smokers and non-smokers. • Amongst quitters, super-gainers were younger, of SES, and differed on a number of health habits before quitting. At follow-up, super-gainers reported changes in health habits significantly different from those with stable weight.	

			• Pairwise concordance for weight change amongst quitters was significantly higher for monozygotes than for dizygote twins.	

1

<table>
<tr><th colspan="5">INDIVIDUAL STUDIES: FAMILIES/AGE</th></tr>
<tr><th>First author, design, aim</th><th>Population</th><th>Intervention details, length of follow-up</th><th>Results</th><th>Confounders adjusted for/Comments</th></tr>
<tr>
<td>Tremblay 1998

Prospective cohort
2+

Aim:
To evaluate changes in participation in PA and in fat and alcohol intake with increasing age.</td>
<td>207 adults (103 males, 104 females; mean age 42.3 years (SD 4.9) at baseline) and their offspring (60 males, 62 females; mean age 12.5 (SD 1.9) years at baseline). All participants of Quebec Family Study, Canada.

Baseline BMI:
Not stated. Baseline weights in kg – mean (SD):
Male adults: 74.6 (11.4)
Female adults: 58.0 (8.6)
Male offspring: 43.2 (12.0)
Female offspring: 41.1 (9.8).</td>
<td>Year of baseline survey:
1978–82

Duration of follow-up:
Average 12 years. Follow-up phase was 1989–94.

Outcome variable:
Mean weight changes (kg) and mean changes in sum of skinfold thicknesses (mm).

Self-reported or measured weight:
Not stated. Skinfold thicknesses measured.

Statistical analysis:
Significant change was tested using paired t test. To assess effects of sex, repeated measures ANOVA.</td>
<td>Attrition:
Not stated.

Mean changes (all significant increases, p > 0.01):
<table>
<tr><th></th><th colspan="2">Parents</th><th colspan="2">Offspring</th></tr>
<tr><th></th><th>Males</th><th>Females</th><th>Males</th><th>Females</th></tr>
<tr><td>Weight changes (kg): mean (SD)</td><td>+2.4 (5.9)</td><td>+4.9 (5.8)</td><td>+29.3 (10.9)</td><td>+16.8 (10.7)</td></tr>
<tr><td>Changes in sum of skinfold thicknesses (mm): mean (SD)</td><td>+15.3 (10.9)</td><td>+35.8 (10.7)</td><td>+21.0 (21.5)</td><td>+27.0 (26.9)</td></tr>
</table>
Before and after values of body weight and skinfold thicknesses were significantly and positively correlated in all groups.

Adult women displayed significantly greater mean increases in body weight and sum of skinfold thicknesses than adult men (p > 0.01).

Association of other factors with weight changes:
Male offspring increased their body weight to a greater extent than females (p > 0.01). Sex differences in offsprings' changes in skinfold thicknesses not mentioned so presumably non-significant (large SDs).

Summary of results:
Body weight and skinfold thickness increased over time in all groups and there were some differences in the size of these increases by sex.</td>
<td>No confounders adjusted for.

Author's conclusions:
The authors note that body weight and skinfold thicknesses increased with age in spite of changes in dietary intake and PA which are commonly thought to facilitate the control of fat balance – suggests strong effect of age-related factors on fat balance.</td>
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2

INDIVIDUAL STUDIES: MARITAL STATUS

First author, design, aim	Population	Intervention details, length of follow-up	Results	Confounders adjusted for/comments
Rauschenbach 1995 Prospective cohort 2+ **Aim:** To evaluate the influence of change in marital status on weight change over 1 year. The National Survey of Personal Health Practices and Consequences – telephone survey.	2436 adults within the US, mean age 39, modal income group US$15,000 to $24,000. **Baseline BMI: not reported**	**Year of baseline survey:** 1979–80 **Duration of follow-up**: 1 year. **Outcome variable**: Weight change. **Self-reported or measured weight:** Self-report. **Statistical analysis:** Regression analysis of weight change and regression analysis of weight at follow-up controlling for baseline weight (not reported as similar to initial analysis) three models – weight change, weight gain and weight loss.	**Attrition:** 81% participated at 1-year follow-up (excluded those with inconsistent height data at follow-up). **Weight changes:** Mean weight change in men was 1.38 (9.94) lb (0.6 [4.5 kg] and 1.26 (10.52) lb (0.8 [4.8] kg), 44% of both men and women gained weight. **Association of other factors with weight change: Marital status** Nineteen men became unmarried and 46 became married; 37 women became unmarried and 33 became married. Women who entered marriage had greater weight change than women who remained married, for men there were no statistically significant relationships between marital change and weight change. In the model to predict weight change none of the interactions were significant; in the model to predict weight gain none of the interactions were significant for women but for men the interaction of education with becoming unmarried was significant (*p* = 0.024) and associated with greater weight gain in more educated that become unmarried.	**Adjusted for:** Age, race, education, family income, children, metropolitan residence; and in model to predict weight change also adjusted for interaction of education, family income and age with change in marital status. **Author's conclusions:** Results suggest gender differences in rate of body weight change after marriage.

1

INDIVIDUAL STUDIES: OCCUPATION- AND WORK-BASED COHORTS				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
Bazzano 2005 Prospective cohort	17,881 US male physicians aged 40 to 82, and free from cardiovascular disease,	Year of baseline survey: 1982 Duration of follow-up: 8 and 13 years	Attrition: 17% Association of diet with weight change: Dietary data were from the Semi-quantitative Food Frequency Questionnaire (SFFQ) and breakfast cereals were classified as either whole	Adjusted for: Age, baseline BMI, alcohol, PA, smoking, histories of hypertension

Aim: To examine the association between whole and refined grain cereals with risk of overweight and weight gain.	diabetes and cancer. Subjects were from the Physicians Health Study which s a completed randomised control trial of aspirin and β-carotene in the prevention of cardiovascular disease and cancer (n = 21,431).	Outcome variable: BMI Self-reported or measured weight: Self-report. Statistical analysis: Various, but all used some form of regression analysis.	or refined grain. Men consuming ≥1 serving per day weighed less than those never or rarely consuming cereals. The trends at 8 and at 13 years were both significant (p-value for trend = 0.001). Men who ate ≥1 serving per day were 22% and 12% less likely to become overweight at 8 and 13 years respectively, compared with men who never/rarely ate cereals; relative risk 0.78; (95 CI 0.67, 0.91) and 0.88; (95 CI 0.76,1.00) respectively.	and high cholesterol and vitamin use. Author's conclusions: **BMI and weight gain were inversely associated with intake of breakfast cereals independently of other risk factors.**
Field 2001 NHS II **Design:** Prospective cohort. **Aim:** To assess the prevalence of clinically significant weight loss among women and whether this is associated with smaller long term weight gains. Secondary to this, the study	A total of 47,515 women from the Nurses Health Study II.	**Year of baseline examination and questionnaire:** 1989 **Duration of follow-up:** 6 years 1989–95 **Outcome variable:** Weight gain (kg) **Self-reported or measured:** Self-reported weights in 1989, 1991, 1993 and 1995, dietary intake, PA, inactivity, history of weight cycling and smoking. **Statistical analysis:** Focused on two main	**Attrition:** Not mentioned. **Weight changes:** During a 2 year period from 1989 to 1991, 2590 (5.5%) women lost 5–9.9% of their 1989 weight and 1326 (2.8%) women lost at least 10% of their 1989 weight. The proportion of women who lost >5% of their baseline weight increased with category of BMI from 3% (5–9.9% weight loss) among women with a BMI <22 to 9% among women with a BMI >30 kg/m^2 in 1989. Between 1991 and 1995, approximately 50% of the women had regained all of the weight they had lost. Among those women who had lost >10% of their 1989 weight, the percentage who regained all of their large weight loss between 1989 and 1991 decreased across baseline categories of BMI from 71% among the women with a BMI <22 kg/m^2 to 54% among the women with a BMI >30 kg/m^2 in 1989. Less than 10% of the women who had large clinically significant weight loss between 1989 and 1991 were able to successfully maintain their weight loss.	**Adjusted for:** Age, smoking, BMI at age 18, weight gain from age 18 to 1989, dietary intake, hours per week of vigorous activity, inactivity and history of weight cycling. **Author's conclusions:** Although few women can completely maintain weight losses, women should not be discouraged

aimed to assess factors associated with weight change over time.		outcomes, weight change and weight loss maintenance. – Linear regression analysis was used to assess whether women who had clinically significant weight loss between 1989 and 1991 had different weight change patterns to their peers. Logistic regression was used to determine whether other factors measured, or the amount of weight lost between 1989 and 1991, predicted successful weight maintenance from 1991 to 1995.	Regardless of the definition of weight maintenance, baseline category of BMI was inversely associated with successful weight loss maintenance. Women who lost greater than or equal to 10% of their weight between 1989 and 1991 gained more weight between 1991 and 1995 than their peers who did not lose weight. **Weight maintenance:** In further analysis limited to a subset of women who had clinically significant weight loss between 1989 and 1991, results showed that the more weight a women lost between 1989 and 1991, the more likely she was to maintain that loss between 1991 and 1995. Each 10 lb (4.5 kg) weight loss approximately doubled the probability that women would maintain her weight loss. History of weight cycling between the ages of 18 and 30 years reduced this likelihood. Severe weight cyclers were approximately 40% less likely to maintain their weight loss and mild weight cyclers 20% less likely. There was no association between inactivity or intake of total energy from dietary fat; however, hours engaged in vigorous activity was a significant predictor of weight loss maintenance between 1991 and 1995. Each hour of vigorous activity increased the likelihood of maintaining the weight over 4 years by 7%. **Association of diet with weight change:** Dietary intake during the years 1990–91 was modestly associated with subsequent weight change from 1991 to 1995. Energy intake had a modest positive association with weight gain, whereas, alcohol intake was associated with less weight gain **Association of physical activity with weight change:** Vigorous PA was protective against weight gain. Women who engaged in ≥5 hours per week of vigorous activity gained approximately 0.5 kg less than their inactive peers between 1989 and 1995. Total hours of activity per week (including walking) was not associated with weight change.	from attempting to lose weight since it was observed that women who had a clinically significant weight loss gained less weight than their peers over the 6-year period of the study. Data support the importance of PA as an effective means to prevent weight gain. Data also suggest that weight maintenance and weight gain prevention efforts should be targeted at young adults since BMI at age 18, weight gain from age 18 to 1989 and history of weight cycling between the ages of 18 and 30 years were all independently

			Physical inactivity was associated with weight change. For each 10 hours per week a women spent sitting at home or at work, she gained approximately 0.11 kg more than her less inactive peers. **Association of other factors with weight change:** BMI at age 18 years and weight change during early adult life were predictive of weight gain. Each one unit difference in BMI at age 18 years was associated with gaining an additional 0.32 kg between 1989 and 1995. This association was slightly attenuated when a history of weight cycling between the ages of 18 and 30 years was entered into the statistical model.	predictive of adult weight gain.
Hannerz 2004 Prospective cohort **Aim:** To explore whether factors related to the work environment could predict changes in BMI and whether the effects of psychosocial factors was dependent on baseline BMI.	Of the 2603 potential study participants, 1980 male employees from the Danish National Work Environment Cohort Study were observed during analysis. **Baseline BMI (kg/m^2):** <20 *n* = 59 20–24 *n* = 1,111 25–29 *n* = 692 >30 *n* = 118	**Year of baseline examination and questionnaire:** 1990 **Duration of follow-up:** 10 years, 1990–2000. **Outcome variable:** The change in BMI between the calendar years 1995–2000. **Self-reported or measured weight:** Self-reported over during a telephone interview, i.e. 'what is your weight? **Statistical analysis:** The change in BMI, as a function of a series of background variables and a series of occupational variables, were analysed by multiple linear	**Attrition:** Not mentioned. **Weight changes:** Among the background variables, age ($p \leq 0.0001$) and baseline BMI ($p \leq 0$ 0003) were statistically significant, and the estimates indicated that the tendency to gain weight decreases with age and BMI. Job security was the only significant occupational variable ($p = 0.157$). Among the psychological variables, that only ones that interacted significantly with baseline BMI were psychological demand ($p = 0.0108$) and job insecurity ($p = 0.0027$). Obese employees with job insecurity gained more weight than obese employees without job insecurity, whereas underweight employees with job insecurity gained less weight than underweight employees without job insecurity. The background variables explained 4.8% of the variation in BMI changes. The model, which incorporated all main effects, explained 5.8%, whereas the model that also included significant interaction effects between psychological factors and baseline BMI explained 7.3%. **Association of diet with weight change:** No such relationships were included. **Association of physical activity with weight change:** PA at work was included in the analysis yet it wasn't statistically significant for predicting changes in BMI ($p = 0.0674$). **Association of other factors with weight change**:	**Adjusted for:** Not stated. **Author's conclusions:** Age, baseline BMI, job insecurity, and psychological demands predict changes in BMI. Job insecurity and high or low psychological demands increase the likelihood of weight gain among obese employees, whereas they increase the likelihood of weight loss among employees with a low BMI.

		regression. In the first model, all of the selected variables were jointly analysed for main effects. In a second model, significant two-way interactions between baseline BMI and psychosocial variables were included. **Background variables:** Age, cohabitation, smoking status and baseline BMI. **Occupational variables:** Long working hours, irregular working hours, PA at work, cold work environment, hot work environment, decision authority, psychological demands, possibilities to communicate with colleagues, conflicts at work and job insecurity.	No other mentioned.	**Comments:** All measures were self-reported and so when it comes to the work-environment variables it is possible that different individuals might have perceived the same objective exposure differently.
Morris 1992 Prospective cohort study (British Regional heart Study). **Aim:**	**Setting:** One general practice in 24 towns in Britain. 6057 men aged 40–59 years who had been continuously	**Year of baseline examination and questionnaire:** 1978–80. **Duration of follow-up:** 5 years (1983–85).	**Attrition:** 7112 men were screened for participation yet 6057 were eligible for inclusion based upon the fact that they had experienced no unemployment in the previous 5 years. **Weight changes:** At initial screening, the mean BMI of men who remained employed was similar to that of men who experienced some non-employment later (25.52 vs. 25.40 kg/m^2, respectively) However, men who later became non-	**Adjusted for:** Age, social class and town of residence **Author's conclusions:** In this group of British middle-

To assess the effect of unemployment and early retirement on cigarette smoking, alcohol consumption, and body weight in middle aged British men.	employed for five years before the initial screening. The men were placed into employment groups based on their employment experience over the five years after screening. 4412 men had been continuously employed (mean BMI = 25.52 kg/ m^2) and 1645 had experienced some unemployment or retired (mean BMI = 25.40 kg/ m^2).	**Outcome variable:** BMI, number of cigarettes smoked and units of alcohol consumed per week. **Self-reported or measured weight:** Self-reported via a standard questionnaire, which included questions on occupational history, employment status, smoking habits, alcohol intake and usual patterns of PA. **Statistical analysis:** The adjusted proportions were calculated by fitting logistic regression models and by using the marginal prediction method described by Wilcosky and Chambless Changes in weight were analysed by fitting a nominal polytomous regression model on the six separate weight change categories.	employed were more likely to be underweight compared with men who remained employed (3.8 vs. 2.7%; 95% CI of the difference 0.1, 2.2). Five years later the mean BMI had risen slightly in both men who had experienced some non-employment (25.40 to 25.71 kg/m^2) and in men who had not (25.52 to 25.77 kg/m^2). The percentage of men who were underweight had fallen 2.7 to 2.0% in men who were employed and 3.8 to 2.3% in men who had experienced unemployment) and the percentage of men who were overweight had risen (8.1 to 8.4% in employed men and 7.9 to 9.4% in men who had experienced non-employment). Men who experienced some non-employment were less likely to remain a stable weight than men who remained continuously employed. 2.9% of men who experienced some non-employment lost more than 10% in weight and 7.5% gained more than 10% in weight compared with 2.1% and 5.0% respectively of continuously employed men (95% CI of the difference 0.1, 1.8 for weight loss and 0.9, 4.0 for gain). There was a strong association between cigarette smoking and BMI, with an increase in BMI occurring on stopping smoking. Excluding men who stopped smoking from the analysis reduced the percentage of men who gained more than 10% in weight. However, non-employed men were still significantly more likely to gain more than 10% in weight than men who remained continuously employed. **Association of diet with weight change:** No dietary analysis as such took place. **Association of physical activity with weight change:** Men who later became non-employed were significantly more likely to be inactive compared with men who remained employed (39.4 vs. 36.7%; 95% CI of the difference 0.1, 5.7). Only men retired for reasons other than illness were significantly less likely to be inactive than continuously employed men (31.6% were inactive; 95% CI 0.4, 0.8). **Association of other factors with weight change:** *Smoking:* At initial screening, compared with men who remained employed men who later became non employed were more likely to be current smokers (43% vs. 37%, respectively; 95% CI of the difference 3.2, 9.0) and	aged men the only evidence of those who experienced non-employment adopting behaviour detrimental to their future health was the increased propensity to gain a large amount of weight (>10%) This was not detected if only mean weight change was analysed. The high levels of smoking and alcohol consumption observed in non-employed men was due to these men being more likely to be heavy smokers and drinkers before the non-employment occurred. There was a strong association

			to be heavy smokers (15.5% vs. 13.1%; 95% CI 0.4, 4.7) They were also more likely to have smoked at some time (22.1 vs. 26.3% who remained employed never smoked; 95% CI 1.5, 6.7). Five years later the level of smoking had fallen: 26.8% of smokers had stopped smoking and only 44.6% of heavy smokers still smoked heavily. Overall men who had experienced some unemployment were still more likely to be current smokers than men who had remained continuously employed (33.0% vs. 29.3% respectively; 95% CI 1, 6.5), but they were no longer more likely to be heavy smokers (7.5 vs. 8.1%; 95% CI 2.1, 1.0). The main changes occurred in men who stated their non-employment was due to illness, with the percentage of heavy smokers falling from 23.6% to 5.8% for men unemployed through illness and from 16.0% to 3.1% for those retired through ill health. *Alcohol:* At initial screening, men who later became non-employed were more likely to be heavy drinkers (12.1%) compared with men who remained employed (9%; 95% CI of the difference 1.3, 5.1). Overall, the percentage of non-drinkers was similar among men who later became non-employed and those who remained employed (5.4 and 5.6%, respectively; 95% CI 1.25, 1.5). Five years later, the percentage of heavy drinkers had fallen (9.0 to 3.0% for men who were continuously employed and 12.1 to 4.1% of men who were non-continuously employed) and the percentage of non-drinkers had risen (5.6 to 8.4% in the employed group and 5.4 to 10.8% in the unemployed group). Overall, only 10.7% of men reported increasing their alcohol consumption compared with 36.9% who reported reducing their consumption.	between illness, unemployment, and changes in body weight, alcohol consumption, and cigarette smoking. The men who stated that their non-employment was due to illness were much more likely to lose weight and to reduce their levels of smoking and drinking than both non-employed men and men remaining continuously employed. **Comments:** The study did not comment on financial pressure that may have lead to the reductions in alcohol consumption.
He 2004 Prospective cohort	In 1976, 121,700 female registered nurses aged	**Year of baseline survey:** 1984 (In this paper, 1984 was considered	**Attrition:** 61% of those who took part in the study in 1976 were included in this analysis.	**Adjusted for:** Covariates stated in statistical

2+ Nurses Health Study: this paper focuses on fruit and vegetable consumption. **Aim:** To estimate the change in BMI over 12 years in a cohort of female nurses, dependent on change (not baseline) in fruit and vegetable consumption over the same time period.	30–55 years from 11 US states responded to a mailed questionnaire. 12-year follow-up. Questionnaire was mailed every other year. Analysis for this paper *n* = 74,063 female nurses aged 38–63 at baseline in 1984. This represented approx 61 % of those who were included in the study at 1976, but unclear how many nurses were originally invited to take part in 1976. **Exclusion criteria:** Cardiovascular disease, cancer, diabetes, incomplete information on questionnaire	as baseline since the expanded food frequency questionnaire [FFQ] was used that year.) **Duration of follow-up**: 12 years. **Outcome variable**: BMI. **Self-reported or measured weight:** Self-report. **Statistical analysis**: Change in intake of fruits and vegetables was ranked from largest decrease to largest increase during the 12-year follow-up period and quintiles of this variable were used in the analysis. ORs were computed using logistic regression models. Multivariate ORs were estimated by simultaneously adjusting for age, year of follow-up, change in PA, change in smoking status, baseline BMI, change in alcohol consumption and caffeine intake, change in hormone replacement therapy, and changes in energy	**Weight changes**: Not reported separately **Association of diet with weight change:** During the 12-year follow-up, participants tended to gain weight with age, but those with the largest increase in fruits and vegetables had a 24% lower risk of becoming obese compared with those who had the largest decrease in intake. OR 0.76 (95% CI 0.69, 0.86), *p* for trend <0.0001. Similar results were observed for changes of fruits and vegetables separately.	analysis. **Author's conclusions:** Increasing intake of fruits and vegetables may reduce long-term risk of obesity and weight gain among middle-aged women.

	(e.g. no data on body weight) or implausible information (e.g. total daily energy intake (TDEI) <600 or >3500 kcal [<2.51 MJ or >14.6 MJ]) **Baseline BMI, mean (SD):** 24.9 (5) kg/m^2	adjusted intakes of saturated fat, polyunsaturated fat, monounsaturated fat, trans-unsaturated fatty acid, protein, and TDEI. The median values of quintiles of changes in fruit and vegetable intake were used as a continuous variable for the tests for linear trend. To estimate the mean difference of changes in BMI by category of fruits and vegetables, general linear models with least-square means was used.		
Schulze 2004 Prospective cohort 2+ **Aim:** To examine the relationships between sugar-sweetened beverage consumption and weight and its links to type 2 diabetes in a cohort of young and middle-	51,603 female nurses from the USA, aged 24 to 44 years were used as subjects. Women were excluded if they did not complete a dietary questionnaire or if subjects reported dietary intake was implausible with regard to total	**Year of baseline survey:** 1991 **Duration of follow up:** 8 years. **Outcome variable:** Weight (kg) and BMI (kg/m^2). **Self-reported or measured weight:** Self-reported. **Statistical analysis:** Difficult to assess. Means calculated for	**Attrition:** 44 % (116,671 recruited at initiation, 51,603 left for analysis). **Weight changes:** Mean change in BMI was 0.49 kg/m^2 for 1991–95 and 0.05 kg/m^2 between 1995–99). **Association of diet with weight change:** From 1991–95 and 1995–99, women who increased their intake of sugar sweetened soft drinks from low to high had significantly larger increases in weight (4.69 kg during 1991–95 and 4.20 kg during 1995–99) and BMI (1.72 kg/m^2 during 1991–95 and 1.53 kg/m^2 during 1995–99) than women who maintained a low or a high intake or significantly reduced their intake ($p > 0.01$). The lowest weight gain and increase in BMI were observed among the women who reduced intake from high to low (1.34 kg in 1991–95 and 0.15 kg during 1995–99.	**Adjusted for:** Age, alcohol, PA, smoking, BMI, other lifestyle and dietary confounders at baseline **Author's conclusions**: A higher intake of sugar-sweetened beverages is associated with a greater magnitude of weight gain and

aged women.	energy intake (i.e. <500 kcal/d or >3500 kcal/d [<2.09 MJ or >14.64 MJ]); if they had history of diabetes, cancer, cardiovascular disease at baseline or if they had not provided data on PA in 1991.	the mean weight changes in groups. Cox proportional hazards analysis was used.	Those who increased consumption of fruit punch from one drink or less per week in 1991 to 1 drink or more per day in 1995 gained more weight (3.69 kg) compared with women who reduced their intake (2.43 kg, $p > 0.001$). Increased fruit juice consumption was associated with larger weight gain (4.03 kg) compared with decreased fruit juice consumption (2.32 kg, $p > 0.001$). Oppositely, weight gain in participants who increased their diet soft drink consumption from one drink or less per week in 1991 to one drink or more per day in 1995 (1.59 kg) was significantly lower compared with women who decreased their diet soft drink consumption from one drink or more per day in 1991 to 1 drink or less per week in 1995 (4.25 kg, $p > 0.001$). Subjects who increased soft drink consumption between 1991 and 1995 and continued with this high level of intake during 1995–99, on average gained 8.0 kg between 1991 and 1999. Women who reduced their consumption between 1991 and 1995 and maintained a low level of intake on average gained 2.8 kg between 1991 and 1999. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** No analysis.	an increased risk for development of type 2 diabetes. This was attributed to excessive energy from the drinks and large amounts of rapidly absorbable sugars found in the drinks.
Koh-Banerjee 2003 Prospective cohort 2+ The Health Professionals Follow-Up Study. **Aim:** To determine the associations of	16,587 US male health professionals (dentists, veterinarians, pharmacists, optometrists, osteopathic physicians and podiatrists) aged 40–75 years. **Baseline BMI:** 40–49 years (*n* = 7577) 24.9	**Year of baseline survey:** 1986 **Duration of follow-up:** 9 years (1986–94 for dietary exposures and 1986–96 for all other exposures) **Outcome variable:** Change in waist circumference. **Self-reported or**	**Attrition:** 1751 excluded due to death, 15,833 excluded due to disease, 17,358 excluded due to incomplete data. **Weight changes:** Mean (SD) waist circumference increased by 3.3 (6.2) cm from 1987 to 1996. **Association of diet with weight change:** 2% increment in energy intake from *trans* fats that were isoenergetically substituted for either polyunsaturated fats or carbohydrates was significantly associated with a 0.77 cm waist circumference gain over 9-years ($p > 0.001$ for each comparison). An increase of 12 g total fibre/day was associated with 0.63 cm decrease in waist circumference ($p > 0.001$).	Adjusted for baseline age, baseline waist circumference, baseline BMI, baseline and changes in total energy, baseline and changes in alcohol consumption, baseline and changes in total PA and changes in

changes in diet, PA, alcohol consumption and smoking with 9-year waist gain in US men.	(2.8) kg/m^2. 50–59 years (*n* = 5314) 25.2 (2.8) kg/m^2. 60–75 years (*n* = 3696) 24.9 (2.6) kg/m^2.	**measured weight:** Self-report waist circumference. **Statistical analysis:** Multivariate linear regression.	Change in total fat intake was significantly related to waist gain of 0.27 cm (*p* > 0.001) but was not significant when further adjusted for concurrent change in BMI; alcohol consumption was not significantly related to waist gain. **Association of physical activity with weight change:** Increases of 25 METs hours per week in vigorous PA and at 0.5 hours per week or more in weight training were associated with 0.38 cm and 0.91 cm decreases in waist circumference respectively (*p* > 0.001 for each comparison). Increases of 25 METs hours per week in vigorous PA remained significant (*p* > 0.05) after control for concurrent change in BMI (–0.19 cm); 0.5 hours per week or more in weight training were associated with 0.74 decreases in waist circumference (*p* > 0.001) after controlling for change in BMI; (also significant decreases in waist circumference with 12–24 MET hours per week and ≥25 MET hours per week. Change in walking volume was not significantly related to waist gain, an increase in walking pace of at least 1 mph (0.45 m/s) was related to loss in waist circumference of 0.50 cm (*p* = 0.002) (–0.27 cm, *p* = 0.05) when BMI held constant); a decrease in walking pace of at least 1 mph was related to a gain in waist circumference of 0.60 cm (*p* > 0.001) (0.26, *p* = 0.03 when BMI held constant). **Association of other factors with weight change: Smoking and TV** Smoking cessation and a 20-hours per week increase in TV watching were associated with a 1.98 cm and 0.59 cm waist circumference gain respectively (*p* > 0.001). Those who quit smoking gained waist circumference 1.98 cm (*p* > 0.001) but this was not significant when change in BMI was controlled for.	smoking. To identify lifestyle factors that predicted increase in waist circumference independent of weight gain changes in BMI were adjusted. **Author's conclusions:** Waist gain may be modulated by changes in *trans* fat and fibre consumption, smoking cessation and PA.
Yamada 2001 Prospective cohort 2+ **Aim:** To clarify the health effects	189 Japanese men, aged 21 to 47 years (mean 31.1 years on the 1 April 1996) who worked in a electronic parts producing factory.	**Year of baseline survey:** 1996 **Duration of follow up:** 3 years **Outcome variable:** Weight (kg) and BMI.	**Attrition:** 1.5% **Weight changes:** For the 12-hour shift workers, mean body weight was 66.6 kg in 1996, 66.6 kg in 1997, 67.6 kg in 1998 that shows a weight gain of 1.0 kg between 1997 and 1998. The BMI of workers on 12-hour shifts increased significantly from 22.8 to	**Adjusted for: not stated** **Author's conclusions:** Implementing a 12-hour shift caused unhealthy

of implementing a 12-hour shift in place of a traditional 8-hour shift in a clean room in an electronic parts-producing factory.	All participants had been working 8-hour shifts for >2 years. Seventeen men aged between 27 and 38 years who had been working 8-hour shifts for >2 years, continued working 8-hour shifts. These were used as a reference group. **Baseline BMI/weight:** Mean baseline BMI of subjects: 22.9 kg/m^2. Subgroup of 20-year-olds: 22.1 kg/m^2. Subgroup of 30-year-olds: 23.4 kg/m^2. Subgroup of 40-year-olds: 23.7 kg/m^2.	**Self-reported or measured weight:** Measured. **Statistical analysis:** StatView 5.0 for windows.	23.2 kg/m^2 for all the workers. The 8-hour shift workers showed a large variation in mean body weight, particularly 67.0 kg in 1996, 66.5 kg in 1997, 67.1 kg in 1998 and 66.3 kg in 1999. 20-year-olds showed a weight gain of 0.8 kg between 1997 and 1998; however, there were only four of them. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** *Age:* 12-hour shift workers – weight gain in the year between 1997 and 1998 was 1.2 kg for the 20-year-olds and 0.9 kg for the 30-year-olds. 40-year-olds showed a weight gain of 0.7 kg in the year between 1997 and 1998 but showed a loss of 1.3 kg between 1998 and 1999. This is a 0.2 kg of body weight over the 3 years. A paired *t* test showed a significant increase in the 12-hour shift workers as well as for the 20-year-olds and 30-year-olds between 1997 and 1998 ($p > 0.05$). For 20-year-olds BMI was 22.0 to 22.4 kg/m^2 and 23.4 to 23.7 kg/m^2 for the 30 year olds between 1997 and 1998. The increase for the 40-year-olds was from 23.8 to 24.0 kg/m^2 with a decrease to 23.6 kg/m^2 in 1999. Eight-hour shift workers – 20-year-olds showed a weight gain of 0.8 kg between 1997–98; however, there were only four of them. Thirty-year-olds showed a weight gain of 0.2 kg between 1997 and 1998 but showed a loss of 1.1 kg between 1998 and 1999. Statistically, no significant changes were found for either the entire 8-hour shift group or the age subgroups during 1996–99. The changes in BMI among the subjects were not found to be significant either ($p > 0.05$). Thirty-year-olds showed a weight gain of 0.2 kg between 1997 and 1998 but showed a loss of 1.1 kg between 1998 and 1999. Statistically, no significant changes were found for either the entire 8-hour shift group or the age subgroups during 1996–99. The changes in BMI among the subjects were not found to be significant either ($p > 0.05$).	weight gain among some clean room workers.

Martikainen 1999 Prospective cohort 2+ **Aim:** To describe socio-economic differences in change in BMI from age 25 years, assess possible factors behind these differences, and study whether socio-economic differences in a variety of coronary risk factors can be accounted for by change in BMI.	5507 men and 2466 women who participated in London-based civil servant Whitehall II study who were 35–55 years old in phase 1 (1985–88) and participated in third phase (1991–1993). **Baseline BMI:** 22.60 (22.53–22.67) kg/m^2 for men, 21.97 (21.84–22.10) kg/m^2 for women.	**Year of baseline survey:** 1985–88 **Duration of follow-up:** 5–6 years **Outcome variable**: BMI gain **Self-reported or measured weight:** Measured but self-reported recall at baseline of weight at age 25 years. **Statistical analysis:** Logistic regression, multinomial logistic regression, linear regression.	**Attrition:** 2335/10308 **Weight changes:** BMI change (mean, 95% CI) from 25 years of age to phase 3: all men 2.52 (2.46, 2.59) (7.8 kg), all women 3.74 (3.59, 3.88) (9.3 kg). **Association of diet with weight change:** Age-adjusted OR of having a gain in BMI >3 kg/m^2 compared with having a BMI gain of 0–3 kg/m^2: Men who reported consuming a good diet (three or four of total of four healthy aspects of diet) had OR 0.73 (95% CI 0.64, 0.84) and for women OR 0.83 (95% CI 0.68, 1.02). **Association of physical activity with weight change:** Age-adjusted OR of having a gain in BMI >3 kg/m^2 compared with having a BMI gain of 0–3 kg/m^2: Moderate and vigorous PA were less likely to experience an increase in BMI, OR for men who took part in vigorous activity was 0.61 (95% CI 0.49, 0.76) and 0.67 (95% CI 0.51, 0.89) for women. **Association of other factors with weight change: employment grade, alchol and smoking** With adjustments for age, duration of follow-up, BMI at age 25 years, the change in BMI was 0.37 kg/m^2 more in grade II than in grade I men and 1.19 for women. The largest grade differences in men and women were observed in those with the largest increases in body mass; men in grade III were 2.5 times more likely to have had a gain in BMI of 6 kg/m^2 or more and for women the OR was 2.8. Age-adjusted OR of having a gain in BMI >3 kg/m^2 compared with having a BMI gain of 0–3 kg/m^2: Grade II men had OR of 1.80 of experiencing a BMI gain of >3 kg/m^2 as compared with grade I men, corresponding OR for women was 2.18. Alcohol consumption was negatively related to BMI gain in women (>10 units per week OR 0.63 (95% CI 0.46, 0.86), consumed 1–2 times per week OR 0.71 (95% CI 0.57, 0.89), consumed daily OR 0.64 (95% CI 0.49, 0.83); in men the relationship was much weaker, with regular and heavy drinkers tending to have a larger gain in BMI.	Grade I = administrative, grade II = professional and executive, grade III = clerical and office support (grade I is the reference group for analyses) Mean change in BMI adjusted for age, duration of follow-up, BMI at age 25 years; OR of having a gain in BMI of >3 kg/m^2 compared with having a BMI gain of 0–3 kg/m^2 was adjusted for age. **Author's conclusions:** Employment grade was strongly related to BMI gain from age 25 years to phase 3 (about 25 years), the lower the grade the larger the gain in BMI, adjustment for

			Male smokers and ex-smokers were more likely to gain BMI (OR 1.49, 95% CI 1.22, 1.82 and OR 1.40, 95% CI 1.22, 1.61, respectively); whereas women were more likely to experience a decline in BMI (OR 0.79, 95% CI 0.61, 1.03 and OR 0.88, 95% CI 0.69, 1.12). Poor health control and poor decision latitude at work were related to body mass gain. **Summary of results:** In men separate adjustment for PA and diet accounted for approximately 15 to 20% of the grade difference of having a BMI gain >3 kg/m^2, adjustment for other explanatory values did not make a major contribution; in women the grade differences in OR of BMI gain could only be accounted for by including alcohol consumption in the logistic regression analysis, but grade differences could be partly accounted for by PA and alcohol consumption (about 20% each) and the model that accounted for all explanatory variables accounted for about one-third of the grade differences.	health behaviours reduced the grade differences in BMI gain by about 20%.
Nakamura 1998 Cohort 2+ **Aim:** To determine whether working overtime is associated with anthropometric indices and serum lipids, risks for obesity in White-collar workers.	Non-management White-collar (programmers, designers, clerical) male workers in printing and personal computer manufacturing company in Fukushima, Japan **Baseline BMI:** 22.6 (3.3), range 15.7–34.2 kg/m^2	**Year of baseline survey:** 1990 **Duration of follow-up**: 3 years (analysed retrospectively). **Outcome variable**: BMI change. **Self-reported or measured weight:** Measured. **Statistical analysis:** Multiple linear regression (stepwise).	**Attrition:** 1990 data for 230 of 248 workers present in 1993. **Weight changes:** Change in BMI over 3 years: 0.55 (1.12), range –2.87–5.98 kg/m^2 **Association of diet with weight change:** Overtime hours were inter-correlated with dinnertime (r = 0.436, p > 0.0001). **Association of other factors with weight change: Overtime** Overtime hours correlated significantly with 3 year **change** in BMI (r = 0.206, p > 0.0017) and waist circumference (r = 0. 218, p = 0.0091) but not with either the most recent anthropometric indices. Working overtime explains less than 5% variability in change in BMI.	Difficult to ascertain which data is cross-sectional and which is longitudinal. Average monthly overtime worked = 45.5 (SD15.6,)range 0–86.1) hours. **Adjusted for:** Not clear. **Author's conclusions:** Working overtime is associated with increases in

				BMI and waist-circumference over 3 years although the associations were weak; eating habits of those working overtime may reflect an intervening effect on anthropometric changes.
Gerace 1996 Prospective cohort 2+ **Aim:** To assess predictors of weight gain that might be used to prevent increases in weight.	438 male paramedics and fire fighters from Dade Country, Florida, USA. Subjects were aged between 20–58 (mean 35.4) years. The subject sample comprised of Black non-Hispanics, White Hispanics and White non-Hispanic. **Baseline BMI/weight:** Mean BMI for those attended in 1984 and 1991: 25.8 kg/m^2.	**Year of baseline survey:** 1984 **Duration of follow-up:** 7 years **Outcome variable:** Weight (lb). **Self-reported or measured weight:** Measured. **Statistical analysis:** Pearson correlation coefficients were calculated for continuous variables. Analysis of variance and covariance programs were run to examine differences in weight change by group.	**Attrition:** Not reported. **Weight changes:** At follow-up mean body weight increased 8.3 lb (3.8 kg) with 65.2% of fire fighters gained 5 lb (2.3 kg) or more, 42.1% gained 10 lb (4.6 kg) or more; 26.1% gained 15 lb (6.8 kg) or more. In 1991 24% were within 4 lb (1.8 kg) of their weight at baseline measurement. 11% of subjects lost ≥5 lb (≥2.3 kg). 41% of the year-to-year changes were actually increases from the previous year, while in the top quartile, 30% of the year-to-year changes were actually decreases in weight. Weight, % of an individual's ideal weight, BMI and triceps skinfold thickness at follow up were inversely related to weight change ($p > 0.01$). Subjects with the smallest anthropometric values in 1984 tended to have the biggest increases in body weight over the 7 years. **Association of diet with weight change:** Fire fighters who ate faster at the station than else where gained 9.9 lb (4.5 kg) by follow up (1991) compared with those who said their pace did not differ by location, who increased 6.8 lb by 1991, while those who did not nibble increased by 6.9 lb (3.1 kg) ($p > 0.05$) **Association of physical activity with weight change:** Self-reported PA levels at baseline were not associated with change in	Outcomes not adjusted. **Author's conclusions:** Prevention programmes will reach fire fighters likely to gain the most weight if aimed at those who are unmarried, younger, Black, recent ex-smokers, fast eaters and experiencing certain stressful life events.

			weight (*p* > 0.05). Likewise, the amount of energy in PA reported at baseline was not associated with weight change (*p* > 0.05). Subjects who reported engaging in at least one recreational PA three or more times per week gained 7.2 lb (3.3 kg) compared with less active fire fighters who gained 9.5 lb (4.3 kg) (*p* > 0.05). **Association of other factors with weight change:** *Demographic variables:* Fire fighters aged 20–29 years, gained the most weight over 7 years (11.3 lb [5.1 kg]). The Pearson correlation coefficient between age and weight change was –0.17 (*p* > 0.01). Subjects who were married or living as married gained 7 lb (3.2 kg) compared with those who were never married, divorced, separated, or widowed who gained 11.7 lb (5.3 kg) (*p* > 0.001). Black non-Hispanics gained 15.7 lb (7.1 kg) compared with White Hispanics who gained 8.9 lb (4.0 kg) and White non-Hispanics who gained 6.7 lb (3.0 kg) (*p* > 0.001). *Behavioural variables:* Fire fighters who smoked at baseline and reported being ex-smokers in 1991 gained 13.0 lb (5.9 kg) compared with all other fire fighters who gained 7.7 lb (3.5 kg) (*p* > 0.004). Ex-smokers who had smoked >20 cigarettes per day gained 16.4 lb (7.4 kg) compared with those who smoked up to 19 cigarettes per day who gained 8.3 lb (3.8 kg). *Psychological variables:* Self-reported stress at baseline was not associated with weight change over the 7-year period (*p* > 0.05). However, those who worried over financial security gained 11.2 lb (5.1 kg) versus non worriers who gained 7.4 lb (3.4 kg) (*p* > 0.005).	

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INDIVIDUAL STUDIES: GENERAL POPULATONS				
First author, design, aim	**Population**	**Intervention details, length of follow-up**	**Results**	**Confounders adjusted for/comments**
Nooyens 2005 Prospective cohort Aim: To study changes in	288 healthy men aged 50-65 years who remained employed or retired over follow-up. Men were from the Doetinchem	Year of baseline survey: 1985–86 Duration of follow-up: 5+ years Outcome variable:	Attrition: 0% Association of diet with weight change: Weight gain and increase in waist circumference were associated with a decrease in fruit consumption (p = 0.01) and fibre density of the diet (p = 0.01), and with an increase in frequency of eating breakfast (p = 0.03). Association of physical activity with weight change:	Adjusted for: Age and behaviour changes at baseline. Author's conclusions:

body weight and waist circumference in men.	Cohort Study (rural Netherlands)	Weight change and waist circumference. Self-reported or measured weight: Measured. Statistical analysis: Linear regression.	Weight gain and increase in waist circumference were associated with a decrease in several physical activities, such as household activities, bicycling (p = 0.03), walking and doing odd jobs (p = 0.02). Association of other factors with weight change: Increase in body weight and waist circumference was higher among men who retired from active jobs (0.42 kg per year and 0.77 cm per year, respectively) than among men who retired from sedentary jobs (0.08 kg per year and 0.23 cm per year, respectively).	Retirement was associated with increases in weight and waist circumference among those with former active jobs, but not among those with former sedentary jobs.
Schulz 2005 Prospective cohort Aim: To identify a dietary pattern predictive of subsequent annual weight change by using dietary composition information.	24,958 middle-aged men and women of the European Prospective Investigation into Cancer and Nutrition-(EPIC) Potsdam cohort, Germany. Men were aged between 24-69 and women 19-70 years.	Year of baseline survey: 1994–1998 Duration of follow-up: 4+ years Outcome variable: Weight change. Self-reported or measured weight: Measured and self-report. Statistical analysis: Linear regression.	Association of diet with weight change: Reduced rank regression method was used to derive dietary patterns with 3 response variables presumed to affect weight change: fat density, carbohydrate density, and fibre density. A scoring system was devised with high scores indicating healthier diet. A food pattern of high consumption of whole-grain bread, fruits, fruit juices, grain flakes/cereals, and raw vegetables, and of low consumption of processed meat, butter, high-fat cheese, margarine, and meat to be predictive of subsequent weight change. Subjects with these food patterns were less likely to gain weight. Mean annual weight gain gradually decreased with increasing pattern score (p-value for trend < 0.0001), i.e., subjects scoring high for the pattern maintained their weight or gained significantly less weight over time compared with subjects with an opposite pattern. The prediction of annual weight change by the food pattern was significant only in non-obese subjects; eg normal weight women (p< 0.0001) vs obese women ((p = 0.184).	Adjusted for: Age, total energy intake, PA, smoking, and other dietary behaviour changes. Author's conclusions: Identified a food pattern characterized by high-fibre and low-fat food choices which helped to maintain body weight or at least prevent excess body weight gain.
Quatromoni 2002 Prospective cohort	1828 non-overweight women from the Framingham Offspring/Spouse	Year of baseline survey: Exam 3, year not given Duration of follow-up:	Attrition: 60% 737 having complete data sets Association of diet with weight change: Five dietary patterns were identified among the cohort at baseline via cluster analysis: 'Heart Healthy', 'Light Eating', 'Wine and Moderate Eating',	Adjusted for: Age, total energy intake, PA, cigarette usage, and

Aim: To investigate relationships between dietary patterns and the development of overweight	(FOS) Cohort. Mean age 45 years, with a range of 30-89 years.	12+ years Outcome variable: BMI >25. Self-reported or measured weight: Measured. Statistical analysis: Various, but all used some form of regression analysis.	'High Fat', and 'Empty Calorie'. Over 12 years, the crude risk of becoming overweight was 29% overall, ranging from 22% of women in the 'Wine and Moderate Eating' cluster to 41% of women in the 'Empty Calorie'. Compared with women who ate a lower-fat, nutritionally varied 'Heart Healthy' diet, women who ate an 'Empty Calorie' diet that was rich in sweets and fats with fewer servings of nutrient-dense fruits, vegetables, and lean food choices were at higher risk for developing overweight; RR 1.4; (95 CI 0.9, 2.2). Women who ate an 'Empty Calorie' dietary pattern were also younger and were more likely to smoke.	other dietary behaviour changes. Author's conclusions: Behavioural interventions may be enhanced by targeting differences in eating patterns, dietary quality, and other lifestyle behaviours of distinct subgroups.
Kahn (1990) Prospective cohort **Aim:** To explore the effects of family income, education and changing marital status on change in BMI over 10 years.	1552 White and Black US men were included in this study of 10-year weight change, therefore representing 77% of the Black and White men who initially entered the Health and Nutrition Examination Survey-I (in 1971–75) at ages 25–44 years.	**Year of baseline examination and interview:** 1971–75 **Duration of follow-up:** 10 years. **Outcome variable:** BMI . **Self-reported or measured:** Measured. **Statistical analysis:** Considering BMI change as a	**Attrition:** Not mentioned **Weight changes: Mean 10-year change:** The mean 10-year change in BMI was similar for the men who were not consistently married and for the men who were married at both baseline and follow-up (0.90 vs. 0.80 kg/m^2, respectively). The non-consistently married men had a significantly wider distribution of this weight-change variable. Multivariate models showed a significant increase in the mean BMI change for men with lower education levels compare with those who had gone beyond 12th grade. Men who became married during the 10-year interval showed a trend towards a greater gain in BMI when compared with men who were consistently married. Those men whose marriage ended appeared to experience a relative loss in BMI.	**Author's conclusions:** Study demonstrated that among US men an education to less than college level was a risk factor for increased mean weight gain and that low family income was a risk factor for major weight gain.

		continuous variable, multiple linear regression was used to estimate the effects of each independent variable of interest. Considering BMI change as a categorical variable, logistic regression analysis was used to estimate the OR of either major weight gain (MWG) or major weight loss (MWL) for subgroups defined by the various categories of family income, educational attainment and marital change.	**Incidence of major weight gain/loss:** The incidence of MWG was generally greater for the men who were not consistently married, among these men there was a higher incidence of MWG for those who had lower incomes or lower educational levels The incidence of MWL was also generally greater for the men who were not consistently married The mid-range weight outcome was generally more common among men who were consistently married, had higher family incomes, or had higher educational levels. **Risk factors for major weight change:** Low family income and either becoming married or remaining unmarried during the 10-year follow-up interval were independently associated with an increased risk of MWG. Education to grade 11 or less was only marginally associated with an increased risk of MWG. Neither low family income nor low education had any effect on the risk of MWL. However, ending a marriage or remaining unmarried was associated with an increased risk of MWL. **Association of diet with weight change:** Not measured. **Association of physical activity with weight change:** The incidence of MWG was lowest among men who reported high levels of PA or whose baseline BMI was between 24.0 and 27.8 kg/m^2. **Association of other factors with weight change:** The incidence of MWG was highest among ex-smokers and those reporting low levels of PA. The incidence of major weight loss was highest for men with the highest BMI at baseline or men who continued to smoke. Black race had no consistent effect on MWG or MWL.	Compared with men who were consistently married, men who become married between baseline and follow-up had an increased risk of MWG while men ending a marriage had an increased risk of MWL. Men unmarried at both baseline and follow-up had an increased risk for both MWG and MWL. Findings indicate that US men in greatest need of help in preventing weight gain are those with low family incomes, those with low educational levels and those who are unmarried. **Comments:** Fluctuations in weight that may

				have occurred during the 10-year follow-up were not recorded in this data; therefore, it failed to include everyone who had a major weight change between baseline and follow-up examinations. The definitions of MWG and MWL cannot identify how much of the weight changes were due to changes in the amount of lean or fat tissue. **Adjusted for:** Race (White, non-White), education, smoking status, age and BMI at baseline, length of follow-up, PA, level of morbidity, energy intake, alcohol intake, special diet

				status and parity.
Andersen 2004 (MONICA) **Aim:** To investigate whether night eating per se predicts weight gain, or weight gain predicts night eating. **Design:** Prospective study with initial examination of the cohort in 1982–83 (M-82), re-examination in 1987–88 (M-87) and a third examination in 1993–94 (M-93).	In 1982 to 83 a total of 3608 Danish citizens born in either 1922, 1932, 1942 or 1952 participated. This group invited for re-examination 5 years later in 1987–88, a total of 2987 subjects participated. Finally, in 1993–94 the cohort was invited for a third examination, and 2436 of the initial 3608 individuals participated in all three examinations. In total, 95/1050 (9.1%) women and 76/1061 (7.4%) men reported night eating. Based on data from the 1987–88 examination 14% of male	**Year of baseline examination and questionnaire:** 1982–83 **Duration of follow-up:** 6 years from 1987–88 to 1992–93 **Outcome variable:** 5-year preceding and 6-year subsequent weight change (kg) **Self-reported or measured weight:** Measured. **Statistical analysis:** Association the between night eating and the preceding weight change, multiple logistic regression models were used. To estimate the effect of night eating on subsequent weight change, multiple linear regression analysis was used.	**Attrition:** 67.5% for all three examinations. **Weight changes:** (M-82 to M-87) Night eating was not associated with weight changes for either sex in the crude and adjusted analyses. Obesity in M-82 did not modify the association between preceding weight change and night eating. (M-87 to M-93) For men, night eating was not associated with subsequent weight change. Analysis revealed that obese women with night eating experienced a greater average 6-year weight gain. The total average 6-year weight gain for obese night eating women was 5.2 kg, whereas obese non-night eating women experienced only a 0.9 kg average weight gain. **Association of diet with weight change:** No specific analysis of food types but reference was made to eating patterns, i.e. restraint when eating meals and data were adjusted for this variable. No significant associations with weight change were observed. **Association of physical activity with weight change:** No specific analysis; however, LTPA was recorded on a four point scale ranging from almost completely inactive, some PA, regular PA and regular hard physical training for competition. Data were adjusted for this variable and no significant associations with weight change were observed. **Association of other factors with weight change:** Other factors considered were present smoking habits and education as recorded by the number of years in school. No significant relationships with weight change were noted for either variable.	Adjusted for Age, smoking, years in school, LTPA, restrained eating and baseline BMI. **Author's conclusions:** Findings indicate that when using a simple yes/no question to assess the night eating phenomenon, obesity and night eating have a joint effect on 6-year weight change for women but not for men, suggesting that night eating maybe a significant contributor to further weight gain among already obsess women but not for others. **Comments:**

	and 13% of female night eaters were obese (BMI > 30) and 11% of male and 9% of female non-night eaters were classed as obese.			A simple yes/no question to identify night eaters with no specific time frame may have reduced the sensitivity of the analyses.
Kant (1995) (NHANES I and NHEFS) Prospective cohort **Aim:** To examine the association of frequency of eating occasions with prospective and retrospective weight change.	In total 7147, 2580 men and 4567 women. All respondents were 25–74 years of age at the time of the initial survey. Mean ages of men and women in the analytic cohort were 44.5 and 45.9 years, respectively.	**Year of baseline examination and survey:** 1971–75 **Duration of follow-up:** 8–10 years . **Outcome variable:** Weight change (kg). **Self-reported or measured:** Measured. **Statistical analysis:** The association of weight change with frequency of eating occasions at baseline and at follow-up were examined using sex-specific multivariate regression analyses. All regression analyses were run with and without adjustment for variables that may potentially affect body	**Attrition:** At follow-up in 1982–84, 46 respondents did not answer the two questions regarding the number of meals and number of snacks consumed daily, leaving 7101 respondents in the follow-up eating occasion cohort. Two or fewer eating occasions were reported by only 2% of the cohort at baseline 24-hour recall. At follow-up, from a summary of two questions on snack and meal frequency, nearly 15% of the cohort reported eating frequency of less than two occasions. Nearly 30% of the cohort reported more than six eating occasions at baseline using 24-hour recall relative to only 5% at follow-up based on answers to two questions on meal and snack frequency. In absolute terms, men and women reported a mean frequency of 5.3 and 4.9 eating occasions at baseline, respectively; at follow-up the mean frequency was 3.6 eating occasions for both men and women. No clear relation between frequency of eating and weight change was evident. **Weight change:** At baseline, weight changes and frequency of eating occasions were positively related in unadjusted models for both men and women. For every unit increase in frequency of eating, men and women gained 0.22 and 0.34 kg of body weight, respectively, over the period of the follow-up. After adjustment for age, and other confounders, the relationship was no longer significant. At follow-up, there was no association of weight change with eating frequency in men or women. **Association of diet with weight change:** At baseline, relative to all other categories, the eating occasion category of	**Author's conclusions:** There was no independent association of frequency of food ingestion estimated from 24-hour dietary recall with prospective weight change or frequency of eating estimated from answers to questions on number of meals and snacks consumed daily with weight change over the preceding 8–10 years in the NHEFS cohort. **Comments:** Twenty-four-hour dietary recall may not

		weight.	<2 was associated with the smallest mean weight change in men, but the largest mean weight change in women. In women, mean baseline BMI, triceps skinfold thickness, subscapular skinfold thickness and plasma cholesterol decreased with increasing baseline frequency of eating occasions. In men, the mean baseline BMI and subscapular skinfold decreased with increasing frequency of eating occasions. Trends in triceps skinfold and plasma cholesterol were not consistent. Mean dietary energy and alcohol intake increased with increasing baseline-eating frequency in both men and women. At follow-up, the highest frequency category (>6) was associated with the largest mean weight change and baseline BMI in women but not men. Mean plasma cholesterol measured at baseline was inversely associated with frequency of eating at follow-up in women but not in men. Mean alcohol intake decreased with increasing frequency of eating at follow-up in both men and women. **Association of physical activity with weight change:** Self-reported level of usual PA at baseline or at follow-up were not related with frequency of eating at baseline or follow-up (data not shown). **Association of other factors with weight change:** Whites, respondents with >12 years educations, and >1 poverty income ratio reported higher mean frequency of eating occasions both at baseline and at follow-up. Current smokers, and alcohol drinkers reported a higher frequency of eating occasions at baseline, but lower frequency at follow-up.	represent respondents 'usual' eating patterns. Different measures of dietary intake were used at baseline and follow-up. The extents of changes in frequency of food ingestion were unable to be measured.
Parsons 2005 Prospective cohort 2+ **Aim:**	All births 3–9 March 1958 in England, Scotland and Wales studied at age 33 and at age 42 years.	**Year of baseline survey:** 1991 **Duration of follow-up**: 9 years	**Attrition:** 860 out of 16460 **Weight changes: not stated** **Association of diet with weight change:** Among women the proportion who decreased chip consumption also	Outcomes not adjusted. **Author's conclusions:** Associations between BMI

To investigate whether adults studies in 1991 and 1999 improved their diet and PA level in the direction of recommendations.	**Baseline BMI:** Not reported.	**Outcome variable**: BMI quartile. **Self-reported or measured weight:** Self-report? **Statistical analysis**: Trends in % subjects increasing/decreasing activity, consumption of chips, fried food or fruit and salad, compared with remaining stable across the BMI quartile were assessed.	increased slightly with higher BMI (*p* > 0.0001); among women proportion who increased fried food consumption increased with lower BMI (*p* = 0.001); among women the proportion who decreased fruit and salad consumption increased with higher BMI (*p* = 0.03); among men significant difference between proportion who decreased chip consumption and between proportion who decreased fired food consumption fried food consumption (*p* = 0.04 and 0.01, respectively). **Association of physical activity with weight change:** No significant differences by BMI group among men and women who increased or decreased PA, or who increased chip consumption, or who increased fruit/salad/raw vegetable consumption.	and change in activity or diet were inconsistent.
Larew 2003 Prospective cohort 2+ **Aim:** To determine the relationship of muscle metabolism to exercise performance (results not relevant to this review) and of exercise performance to rate of weight gain	83 Black and White premenopausal women aged 23–47 years (mean age 34 [6.1] years with normal body weight (BMI 21–25 kg/m^2); some had previously been overweight; normal glucose tolerance, not smoked in previous year, not taking medication known to affect metabolism. **Baseline BMI:** 23.6	**Year of baseline survey:** Not reported. **Duration of follow-up**: 1 year. **Outcome variable**: Change in weight. **Self-reported or measured weight:** Measured. **Statistical analysis**: Multiple regression analysis.	**Attrition:** 61 of 83 subjects returned at 1 year. **Weight changes:** Mean rate of weight gain 3.8 (4.7) kg/year/to the power minus 1 (range –5.6kg/year/to the power minus 1 to 12.8 kg/year to the power minus 1). **Association of physical activity with weight change:** Greater muscle metabolic economy (*r* = –0.25, *p* = 0.04); greater quadriceps muscle strength (*r* = –0.34, *p* > 0.01); greater VO_{2max} (*r* = –0.22, *p* = 0.04) and longer treadmill endurance time (*r* = –0.21, *p* = 0.04) were significantly correlated with lower rates of weight gain over 1 year. Muscle metabolic economy, VO_{2max} and quadriceps muscle strength all independently and significantly contributed to the estimate of rate of weight gain model and the model explained 23% of weight gain variability (*r* = 0.48, *p* > 0.01). **Association of other factors with weight change (please state factors):** None.	**Adjusted for:** Not reported. **Author's conclusions:** Greater exercise endurance reduces weight gain.

<table>
<tr><td></td><td>(1.2) kg/m^2,
n = 83.</td><td></td><td></td><td></td></tr>
<tr><td>Sammel 2003

Prospective cohort
2+

Aim:
To evaluate correlates of weight gain in women aged 35–47 years.</td><td>336 African American and White American women, urban residents (Philadelphia, PA, USA), participating in the Penn Study of Ovarian Aging.

Age at baseline between 35 and 47 years; mean 41.0 years (SD 3.5 years). Premenopausal at baseline.

Baseline BMI:
29.3 (8.2) kg/m^2.</td><td>**Year of baseline survey:**
Not reported.

Duration of follow-up:
4 years (seen six times after baseline measurements – about 8 months apart).

Outcome variable:
A net weight gain of more than or equal to 10 lb (4.5 kg) at the final assessment compared with baseline (dichotomous).

Self-reported or measured weight:
Measured.

Statistical analysis:
Multivariate logistic regression models. The final model was developed using backward selection.</td><td>**Attrition:**
23%

Weight changes:
Median weight change was 2.4 lb (1.1 kg). 25% of the women gained 10 lb (4.5 kg) or more.

1. Unadjusted associations (all adjusted only for BMI categories at baseline, except BMI category, which is completely unadjusted).

Association of diet with weight change:
Summary dietary variables (average no. of servings per day, adjusted for):

<table>
<tr><th></th><th>Weight gain of >10 lb (4.5 kg) Yes</th><th>No</th><th>*p* value</th></tr>
<tr><td>**Fruit/vegetables**</td><td>**3.4**</td><td>**4.3**</td><td>**0.055**</td></tr>
<tr><td>Breads/cereals</td><td>1.8</td><td>2.0</td><td>0.606</td></tr>
<tr><td>Dairy foods</td><td>2.7</td><td>2.8</td><td>0.898</td></tr>
<tr><td>**Sweets**</td><td>**0.9**</td><td>**1.5**</td><td>**0.015**</td></tr>
<tr><td>Protein</td><td>1.1</td><td>1.7</td><td>0.086</td></tr>
<tr><td>High fat foods</td><td>2.1</td><td>2.2</td><td>0.739</td></tr>
</table>

Association of physical activity with weight changes:
No analysis.

Physical activity variables (average per day):

<table>
<tr><th></th><th>Weight gain of >10 lb (4.5 kg) Yes</th><th>No</th><th>*p* value</th></tr>
<tr><td>No. of blocks walked</td><td>10.5</td><td>10.5</td><td>0.698</td></tr>
<tr><td>Hours vigorous activity</td><td>1.1</td><td>1.1</td><td>0.651</td></tr>
<tr><td>No. of flights of stairs climbed</td><td>9.5</td><td>8.9</td><td>0.667</td></tr>
</table>

Association of other factors with weight changes:

Other variables:</td><td>**Adjusted for:**
Independent variables – all at baseline.

The lack of association between significant weight gain and dietary and PA variables may reflect the relatively crude methods used to measure them. Diet measured with FFQ. PA variables were also self-reported and depended on recall. Recall bias may have been a factor.

Sample was unrepresentative – high attrition could have created bias; only urban women and two ethnic groups represented.

Author's conclusions:</td></tr>
</table>

Significant:
Those with significant weight gain:

- Were more likely to be younger ($p = 0.039$);
- Were more likely to have a high anxiety score ($p = 0.037$);
- Had a lower average Quality of Life score ($p = 0.041$).

Marginally significant:
Those with significant weight gain:

- Were more likely to have a high depression score ($p = 0.053$);
- Had a greater number of pregnancies ($p = 0.086$);
- Were more likely to be on a diet ($p = 0.082$).

Non-significant:

- BMI category; waist-to-hip ratio;
- Perceived stress;
- Current cigarette smoking status; alcohol consumption (average. no of drinks per week);
- Race; education; whether employed outside the home;
- Reproductive hormone values.

2. Final model (with significant results in **bold**):

	OR	**95% CI**	***p* value**
BMI (kg/m^2)			**0.008**
<21	**0.21**	**0.03–0.56**	
21–24	–	–	
25–29	0.90	0.44–1.82	
30+	0.62	0.32–1.23	
Age (years)			**0.054**
35–39	–	–	
40–44	0.80	0.44–1.43	
45–49	**0.39**	**0.18–0.87**	
Race			0.741
White	–	–	
African	1.11	0.61–2.00	
Education			0.632
> High school	–	–	
> High school	1.26	0.48–3.31	
Increasing parity	1.12	0.97–1.29	0.129

The major predictors of weight gain were psychological factors – depressed mood, anxiety and quality of life.

			Depression score — **0.024** <16: –, – >16: **1.90**, **1.09–3.31** **Increased consumption of sweets**: **0.74**, **0.60–0.91**, **0.004** **Summary of results:** • Underweight women were least likely to experience significant weight gain. • A high depression score made significant weight gain twice as likely. • The only significantly predictive dietary variable was *low* consumption of sweet foods. • PA variables were not predictive of significant weight gain.	
Kahn 1991 Two prospective cohort studies from NHANES 2+ **Aim:** To examine the association between race and weight gain in adults, and whether this can be explained by socio-economic confounders. Kahn 1991 2+ Analysed the female sample – the same except defined	A population sample of Black and White US adults who entered NHANES I at ages 25–44 years. 3284 women (84% White); 1552 men (90% White). **Baseline BMI:** Not stated	**Year of baseline survey:** 1971–75 **Duration of follow-up**: About 10 years – follow-up was between 1982 and 1984. They computed an estimated weight change for exactly 10 years for each participant by linear adjustment. **Outcome variable**: Mean BMI change (kg/m^2) as a continuous variables and separately in three categories: Major weight gain: BMI ≥ +5.0 for women, BMI ≥ +4.0 for men Major weight loss: BMI ≥ –2.5 for	**Attrition:** White women: 23%; White men: 21%. Black women: 30%,; Black men: 40%. **Mean BMI changes (kg/m^2):** White women: +1.07 (SD 3.00); White men: +0.81 (SD 2.37). Black women: +1.38 (SD 3.48); Black men +0.98 (SD 2.25). **Effects of variables:** **Association of diet with weight change:** No analysis. **Association of physical activity with weight changes**: No analysis. **Association of other factors with weight changes:** **1) Mean BMI change** a) Unadjusted • Women: The mean BMI change was significantly greater for Black than White women (unadjusted difference = 0.31 BMI points, 95% CI 0.01, 0.63). The variance in weight change was significantly higher in Black women (p > 0.0001). • Men: There was no significant different in mean BMI change (or variance in mean BMI change) in Black vs. White men.	**Confounders adjusted for:** Age, BMI at baseline, smoking, PA, parity, rural vs. urban background, region of the country. **Author's conclusions:** Black race does not increase the risk of weight gain; in women it may be associated with reduced likelihood of weight loss. In addition, unadjusted effects of race may be mainly to do with family incomes, as a

major weight change using change in kg rather than kg/m^2.

The pattern of results was the same as in Kahn & Williamson 1991, so the results of only the latter are described here.

women, BMI ≥ –2.0 for men)
Mid-range weight change.

Self-reported or measured weight:
Measured.

Statistical analysis:
When BMI change considered as a *continuous* variable: multiple linear regression models.
When BMI change considered as a *categorical* variable: logistic regression analyses where weight gain / weight loss were considered in comparison to the mid-range weight change reference group.

b) Adjusted (see next column for confounders). Effects of variables on mean 10-year change in BMI. Significant results (p > 0.05) in **bold**.

	Women	Men
Race		
White	–	–
Black	**+0.6**	+0.2
Family income		
Favourable	–	–
Moderately low	0.0	+0.2
Low	–0.1	–0.1
Education		
>12th grade	–	–
12th grade	**+0.3**	**+0.3**
<12th grade	**+0.3**	**+0.6**
Marital change		
Stayed married	–	–
Marriage ended	**–0.4**	–0.3
Became married	**+0.8**	+0.4
Stayed unmarried	+0.1	0.0

2) Major weight change

a) Unadjusted. These are percentages.

	Major weight gain		Major weight loss	
	Women	**Men**	**Women**	**Men**
Race				
White	7.6	6.9	6.9	8.9
Black	11.1	7.3	8.8	9.3
Family income				
Favourable	7.1	5.6	5.4	9.2
Moderately low	10.3	7.4	9.3	7.4
Low	12.1	9.7	11.9	10.8
Education				
>12th grade	6.4	6.1	5.2	9.3
12th grade	8.9	6.6	6.9	8.7
<12th grade	8.5	9.3	9.3	9.0
Marital change				
Stayed married	7.8	6.1	6.5	8.3
Marriage ended	7.4	4.4	10.1	11.4

greater proportion of Black than White women had low incomes.

Became married	13.6	15.8	3.6	6.3	
Stayed unmarried	9.1	11.4	8.3	13.6	

b) Adjusted (see next column for confounders).

i) Adjusted OR for **major weight gain**. Significant results (*p* > 0.05) in **bold**.

	Women	Men
Race		
White	–	–
Black	1.1	0.8
Family income		
Favourable	-	-
Moderately low	1.4	1.3
Low	**1.7**	**1.8**
Unknown	0.8	1.8
Education		
>12th grade	–	–
12th grade	1.2	1.2
<12th grade	0.9	1.6
Marital change		
Stayed married	–	–
Marriage ended	0.8	0.7
Became married	**1.8**	**3.3**
Stayed unmarried	0.9	**2.1**

ii) Adjusted OR for **major weight loss**. Significant results (*p* > 0.05) in **bold**.

	Women	Men
Race		
White	–	–
Black	**0.6**	0.8
Family income		
Favourable	–	–
Moderately low	1.4	0.8
Low	**1.8**	1.1
Unknown	1.6	0.6
Education		
>12th grade	–	–
12th grade	0.9	0.9

			<12th grade 0.7 0.9 **Marital change** Stayed married – – Marriage ended 1.2 **1.8** Became married 0.6 1.3 Stayed unmarried 0.8 **2.5** **Summary of results:** **Race** • No significant effects by race for men. • Black women had a greater mean BMI change than White women, even when adjusting for confounding variables (independent effect of race was 0.6 kg/m^2, $p > 0.05$). This is, however, probably due to differences in odds of major weight *loss* (Black vs. White women: adjusted OR 0.6, $p > 0.05$). Although the crude incidence of major weight gain was nearly 50% higher in Black than White women, race did not independently alter odds of major weight gain in women. **Family income** No effect for mean BMI changes but low income was associated with significantly greater odds of major weight gain in both men and women and greater chance of major weight loss only amongst women. **Education** Less education was independently associated with greater mean BMI change in both men and women. No effects by education for major weight change. **Marital variables** Women's but not men's mean BMI change showed effects for marital change (increase with start of marriage, decrease with end of marriage). Women were more likely to experience major weight gain if they became married than if they were consistently married. Men were more likely to experience major weight gain if they became married or if they stayed unmarried than if they were consistently married. Men were more likely to experience major weight loss if they stayed unmarried or if their marriage ended than if they were consistently married.	
Lissner 1997 Prospective	361 healthy women	**Year of baseline survey:** 1968–69	**Attrition:** 437 of the original baseline sample were randomly selected to attend follow-up interview (for diet history). 373 of these also took part in the	**Confounders controlled for were:**

<table>
<tr>
<td>cohort
2+

Aim:
To test the hypothesis that a high-fat diet has a different predictive value for long-term weight change at varying levels of PA.</td>
<td>participating in The Population Study of Women in Gothenburg, Sweden. 38–60 years old at baseline.

Baseline BMI (kg/m^2):
Lower fat consumers: 24.6 (4.1); higher fat consumers: 24.1 (4.1) (no significant difference).</td>
<td>Duration of follow-up: 6 years.

Outcome variable: Mean weight change (kg).

Self-reported or measured weight: Measured.

Statistical analysis: Multivariate regression analysis. Where interactions were significant, did stratified analysis - effect of dietary fat on weight change in each separate PA group. Leisure time and occupational PA analysed separately. Computation of activity categories reported elsewhere. Low fat intake defined as <38.5% energy from fat; high as 38.5%+.</td>
<td>follow-up examination (for follow-up weight measurement). Twelve excluded because of cancer, myocardial infarction, stroke or diabetes at baseline. Suggests attrition of 17%.

Weight changes:
Lower fat consumers (n = 180): +0.64 (1.8) kg
Higher fat consumers (n = 181): +0.79 (1.8) kg

Association of diet with weight change:
No analysis.

Association of physical activity with weight changes:
Leisure time physical activity: In the prediction of weight change, there was a significant interaction (p = 0.03) between PA level and dietary fat.

1) Unadjusted analysis. Dietary fat consumption predicted weight gain in the physically inactive women (p = 0.03) but not in the two groups reporting higher activity levels.

Weight change in kg, mean (SD):

<table>
<tr><th></th><th colspan="3">LTPA category</th></tr>
<tr><th></th><th>Sedentary</th><th>Somewhat active</th><th>More active</th></tr>
<tr><td>Low-fat group</td><td>–0.64 (1.09)</td><td>1.96 (0.39)</td><td>1.27 (1.07)</td></tr>
<tr><td>High-fat group</td><td>2.64 (0.96)</td><td>1.25 (0.40)</td><td>1.92 (1.01)</td></tr>
<tr><td>Difference</td><td>+3.28</td><td>–0.71</td><td>+0.65</td></tr>
<tr><td>p value</td><td>0.03</td><td>0.20</td><td>0.66</td></tr>
</table>

2) Adjusted analysis of weight change (kg). Same pattern of result except that effect of fat intake on weight gain in sedentary group is now only marginally significant (p = 0.06).

Adjusted least-squares mean weight change in kg, mean (SD):

<table>
<tr><th></th><th colspan="3">LTPA category</th></tr>
<tr><th></th><th>Sedentary</th><th>Somewhat active</th><th>More active</th></tr>
<tr><td>Low fat group</td><td>–0.59 (1.07)</td><td>2.05 (0.39)</td><td>1.27 (1.08)</td></tr>
<tr><td>High fat group</td><td>2.24 (0.97)</td><td>1.17 (0.40)</td><td>1.93 (1.02)</td></tr>
<tr><td>Difference</td><td>+2.83</td><td>–0.88</td><td>–0.06</td></tr>
<tr><td>p value</td><td>0.06</td><td>0.12</td><td>0.67</td></tr>
</table>
</td>
<td>Initial body weight, current smoking status and age.

No adjustment for socio-economic factors.

Author's conclusions:
Sedentary recreational activity plus a low-fat diet may have a combined contribution to weight change that is not equivalent to the sum of the separate effects.</td>
</tr>
</table>

			Same pattern of results for overall energy intake. The high-fat association with weight gain in the sedentary group became marginally significant after controlling for overall energy intake and vice versa – i.e. the two dietary measures explained the same variance. *Occupational physical activity:* No interactions, data not shown in paper. **Association of other factors with weight changes:** No analysis. **Summary of results:** Women's fat intake was a predictor of 6-year weight gain *only* amongst women sedentary in leisure time.	
Ball 2002 Prospective cohort 2+ **Aim:** To investigate patterns of weight change, the incidences of major weight gain, overweight and obesity and how weight varied by sex, age, education, and initial body mass.	12,125 men and 17,674 women aged 35–69 years from Melbourne, Australia. **Baseline BMI or weight:** 1.1% of men and 4.1% of women were underweight; 28.2% of men and 41.0% of women were in healthy weight range; 53.2% of men and 35.7% of women were overweight; and 17.5% of men and 19.2% of women were obese.	**Year of baseline survey:** 1994 **Duration of follow-up:** 5 years **Outcome variable:** Weight change **Self-reported or measured weight:** Measured at baseline and self report throughout the rest of the study **Statistical analysis:** Linear regression.	**Attrition:** Not reported. **Weight changes:** Women gained (2.42 kg) significantly more ($p > 0.01$) weight than men (1.58 kg). Within each ethnic group, women gained significantly more weight than men ($p > 0.01$). Mean weight changes were 1.54 kg and 2.35 kg, respectively, for Anglo-Celtic men and women; 1.82 kg and 1.68 kg, respectively for Greek men and women; and 1.64 kg and 2.69 kg, respectively, for Italian/Maltese men and women. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change: Age, education, baseline weight** *Age:* Those in younger age groups gained significantly more weight than older groups, with those aged 35–44 years gaining the most weight within every sex or ethnic group. In all three ethnic groups, younger men were more likely to report larger weight gains ($p > 0.01$ for all groups), with men aged 35–44 years more likely than any other age group to have gained 2–4.99 kg, 5–9.99 kg or 10 kg or more. Younger women ($p > 0.01$ for all ethnic groups) were more likely to	**Adjusted for:** Not reported. **Author's conclusions:** Findings of widespread weight gain and obesity across the entire population sample, particularly among younger women and women who were already overweight, are a cause for alarm.

			experience moderate to large weight gains. *Education:* Education level was not significantly associated with weight gain, except among Anglo-Celtic men, with those who were tertiary educated gaining most weight. Education level was not associated with weight change for Greek (p = 0.23) or Italian/Maltese (p = 0.13) men. Anglo-Celtic men who were primary educated were the most likely to have maintained their weight, and those who were tertiary educated were most likely to report small to moderate gains (2–9.99 kg) (p > 0.05). However, education level was not associated with weight gain among women in any ethnic group. *Baseline weight:* Obese Anglo-Celtic women were likely to gain 10 kg or more than were all other women. Across all three ethnic groups, overweight and obese women also tended to be more likely than other women to report major weight loss (>10 kg).	
Ball 2002 Prospective cohort 2+ **Aim:** To investigate the prevalence and predictors of weight maintenance over time in Young Australian Women. More specifically relationships between weight maintenance and behavioural factors like PA, diet, and	8726 young women, who are residents of Australia, aged 18–23 years at baseline. **Baseline BMI or weight:** 47% of women were categorised as having a healthy weight (BMI 20–25 kg/m^2), 23.3% as overweight or obese (BMI 25–30 kg/m^2) and 11% who had height or weight missing and could not be classified.	**Year of baseline survey:** 1996 **Duration of follow-up**: 4 years. **Outcome variable**: BMI/ weight. **Self-reported or measured weight:** Self-reported. **Statistical analysis**: Logistic regression.	**Attrition:** 0% **Weight changes:** Only 44% of the women reported their BMI at follow up to be within 5% of their baseline BMI; 41% had gained weight and 15% had lost weight. **Association of diet with weight change:** Restrictive eating practices (p > 0.05) and women who reported eating takeaway occasionally were 15% less likely to be weight maintainers than those who rarely or never ate takeaway. **Association of physical activity with weight change:** Women who reported moderate or high sitting time were 17–20% less likely to have maintained their weight **Association of other factors with weight change: Smoking** **Smoking** was significantly associated with decreased likelihood of weight maintenance. Low **alcohol** intake was associated with increased likelihood of maintaining weight. Weight maintainers were more likely to be in managerial or professional occupations; to have never married; to be currently studying and not to be	**Adjusted for:** Not reported. **Author's conclusions:** Early adulthood may be an important time for implementing strategies to promote maintenance of healthy weight.

alcohol consumption.			mothers.	
Bell 2001 Prospective cohort 2+ **Aim:** To describe and analyse 8-year weight change in Chinese adults and to determine the baseline characteristics of those who gained weight in the time period.	2488 Chinese adults aged between 20–45 years from seven provinces of China. **Baseline BMI or weight:** Mean weight of males 58 kg and BMI 21.2 kg/m^2. Mean weight of females 52 kg and BMI 21.7 kg/m^2.	**Year of baseline survey:** 1989 **Duration of follow-up**: 8 years. **Outcome variable**: Weight (kg), BMI. **Self-reported or measured weight:** Measured. **Statistical analysis**: Multiple logistic regression.	**Attrition:** 41% **Weight changes:** Mean BMI increased from 21.5 to 22.4 kg/m^2. From 1989 to 1997 the proportion of underweight men and women dropped by 2.3% and 4.4%, respectively. There was a 9% increase in the proportion of men and women who were overweight. The prevalence of obesity in women increased 7-fold from 0.2 to 1.5% over 8 years. By 1997 14.1% of men and 20.7% of women were overweight or obese compare with 5.0 and 10.5% in 1989. Overweight (BMI > 25 kg/m^2) doubled in females (10.4–20.8%) and almost tripled in males (5.0–14.1%). **Association of diet with weight change:** Energy intake did not affect the risk of weight gain. **Association of physical activity with weight change:** Men who experienced large weight gain (>5 kg) were three more times likely to have engaged in light rather than heavy work related activity, two and a half times more likely to have engaged in moderate rather than heavy PA. For men, having light to moderate activity levels at work (vs. heavy) was predictive of subsequent weight gain. Only PA played a role in weight gain for women. Women who gained >5 kg were 83% and 69% more likely to have done light and moderate rather than heavy PA compared with those who remained stable weight. **Association of other factors with weight change: Height, education, alcohol, smoking** For men, being **tall** at baseline and having a college **education** (vs. primary school education) were predictive of subsequent weight gain. For women having a college education at baseline was predictive of subsequent weight loss. Men who experienced large weight gain (>5 kg) were 55% more likely to have consumed **alcohol**. **Smoking** did not affect the risk of weight gain.	**Adjusted for:** Anthropometric and socio-economic variables were included as control variables. **Author's conclusions:** The prevalence of overweight increased dramatically in this particular cohort. Light work-related PA was the strongest predictor of the weight gain.
DiPietro 1998 Prospective cohort 2+	4599 men and 724 women with an age range of 20–82 years (mean	**Year of baseline survey:** 1970 **Duration of follow-up**:	**Attrition:** Not stated. **Weight changes**: Small weight gain over the follow up (0.61 ± 5.29 kg for men and	**Adjusted for**: Age, height, baseline weight, baseline treadmill time,

Aim: To determine the longitudinal relationship of change in cardiopulmonary fitness to subsequent change in body weight in a cohort of healthy middle-aged adults.	43 ± 9 years) from Dallas, TX, USA (no personal history of heart attack, hypertension, stroke or diabetes and no resting electrocardiogram (ECG) or exercise ECG abnormalities). **Baseline BMI or weight:** Mean weight of men: 81.2 ± 10.7 kg. Mean weight of women: 43.1 ± 8.7 kg.	24 years. **Outcome variable**: Weight (kg). **Self-reported or measured weight:** Measured. **Statistical analysis**: Multivariate linear regression.	1.51 ± 4.67 kg for women; *p* > 0.001), which is consistent with population trends for middle-aged adults. NB: These summary statistics, however, may mask heterogeneous patterns of change, as some participants lost substantial amounts of weight over the follow-up, while others gained weight. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** *Physical activity and television viewing:* Each 1 min improvement in treadmill time, significantly attenuated weight gain in both men (*p* > 0.001) and women (*p* > 0.001), respectively. Each 1 minute improvement in treadmill time, reduced the odds of a >5 kg gain by 14% in men and by 9% in women; and the odds of a >10 kg gain by 21% in both men and women. Higher baseline levels of PA and lower levels of TV/video viewing remained independently related to a lower risk of becoming overweight. The association between the 2-year change in PA or TV/video viewing and the 2-year change in BMI was also examined in the same male cohort. This suggests a small significant correlation between changes in activity or sedentary behaviour and BMI. Each 10 METs per week increase in PA (1 extra hour of running per week) was associated with a 0.03 BMI (0.44 kg) attenuation in weight gain and each 10 hour per week increase in TV/video viewing correlated with an excess weight gain of 0.05 BMI units (0.73 kg) over 2 years. .	smoking status, number of clinic visits and follow up time were all adjusted for. **Author's conclusions:** Improvements in fitness, appear important in attenuating age-related weight gain in healthy middle-aged adults. Thus, an active lifestyle should be promoted early and maintained through adulthood to prevent substantial weight gain and obesity with age.
Droyvold 2004 Prospective cohort 2+ **Aim:** To study the association between PA at baseline and change in BMI	9357 healthy women aged 20–49 years who had a normal body weight (a BMI of 18.5 – 24.9 kg/m^2) at baseline from Nord-Trondelag County, Norway (not >50 years	**Year of baseline survey:** 1984–86 **Duration of follow-up**: 9 years. **Outcome variable**: BMI. **Self-reported or measured weight:**	**Attrition:** Not reported. **Weight changes:** Mean BMI gain was 2.5 (range 5.6 –18.5) kg/m^2. The mean BMI increased in all age cohorts and in all categories of LTPA, smoking, education, baseline BMI, marital status and alcohol consumption. By follow-up 60.3% were in the normal weight category and the proportion of those in the overweight category (BMI of 25.5–29.9 kg/m2) was 36.4%. 3.1% were classified as obese (BMI >30 kg/m2). 1.3% of subjects gained >5 kg during the 11th year of follow-up time and	**Adjusted for:** Age, education and BMI at baseline to investigate association between LTPA and BMI 11 years later. **Author's conclusions:**

during follow up (11 years).	old and no reports of diabetes, stroke, angina, myocardial infarction, or long term illness impairing their function in daily life). **Baseline BMI or weight:** Average BMI of 22.0 kg/m^2.	Measured. **Statistical analysis**: Linear regression.	only 1.4 % lost >5 kg. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** Those with moderate and high levels of leisure PA at baseline gained less weight than those with low levels. However, the observed difference in mean weight change between low and moderate levels of LTPA did not reach statistical significance. Those with high level of activity gained 0.18 kg/m^2 (95% CI 0.05, 0.32) less than those with low level of PA over 11 years. **Association of other factors with weight change: BMI, age, PA, education, alcohol** Characteristics associated with highest BMI gain were high baseline BMI level, younger age, low or moderate LTPA level, low level of education and not drinking alcohol in the last 14 days.	LTPA has a moderate effect on BMI. However, not even a high level of LTPA was sufficient to prevent weight gain and BMI increase in all subgroups of the study population.
Hardy 2000; Langenberg 2003 Prospective cohort 2+ **Aim:** To investigate the effect of childhood weight and childhood socio-economic status on the pattern of change in BMI between 20 – 53 years.	2547 women and 2815 men born in the first week of March in 1946 from **England, Scotland and Wales.** **Baseline BMI/weight:** Number of men overweight (BMI >25 kg/m^2): 134 Number of men obese (BMI >30 kg/m^2): 8 Percentage of men overweight: 11.5% Percentage of men obese:	**Year of baseline survey:** 1946. **Duration of follow-up:** 53 years. **Outcome variable:** BMI. **Self-reported or measured weight:** Ages 7–14, 36, 43 and 53 years measured . Other ages self-reported. **Statistical analysis:** Repeated measures.	**Attrition:** At 43 years 6.8 % had died, 12.1 % had withdrawn from the study, 11.5% were living abroad and 8.8% had temporarily refused to participate or could not be traced. **Weight changes:** In general, the rate of increase in BMI with age was non-linear, with the rate of increase in mean BMI accelerating with increasing age at differing rates for both sexes**.** Mean BMI, which was calculated separately for each measurement, increased with age for both sexes and at every age the mean BMI was lower among women than men. Birth weight was positively associated with adult BMI (0.53 kg/m^2 for every kg increase in birth weight). **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** *Age:* There was a greater percentage of men overweight (>25 kg/m^2) at	**Adjusted for:** Assessment of influence of father's social class at 4 years of age was adjusted for offspring's own social class in young adulthood and middle-age (Langenberg). Final childhood risk factor model was adjusted for adult social class and educational attainment to assess whether the influence of

	0.7% Number of women overweight: 113 Number of women obese: 16 Percentage of women overweight: 10.1% Percentage of women obese: 1.4%		each age but a lower percentage obese (>30 kg/m^2). At all ages those from a manual **social class** had a greater proportion classified as overweight and obese compared with those from non-manual social classes. Of those overweight at 20 years and by 43 years, 80% were overweight. The increase in obesity was also very high in this particular group increasing from 6% at 20 years to 35% at 43 years. For men at age 20 years the estimated mean BMI was 23.33 kg/m^2 while for women it was 21.72 kg/m^2. The estimated mean linear increase in BMI was greater among men at 0.12 kg/m^2 per year than women for whom it was 0.03 kg/m^2. Women had a mean BMI of 0.61 kg/m^2 less than men at 20 years, which is 1 kg/m^2 less at both 26 and 36 years with the difference decreasing again to 0.6 kg/m^2 less at 43 years. *Social class:* Father's social class at 4 years was inversely associated with adult central and total obesity at age 53 years in both men and women. The mean difference of waist-to-hip ratio between fathers professional social class I and unskilled manual social class V was 2.6 (range 0.7–4.6)% for men and 2.5 (range 0.5–4.4)% for women. The effect of fathers social class remained after adjustment for participants own social class in young adulthood and middle age. Both adult social classes were inversely related to obesity among women, but not men. Active men and women were less obese than participants remaining in their fathers' social class and their levels of obesity tended to be between the class they left and the class they joined. At 14 years, mean BMI and faster rate of increase than others and those from a manual social class background had a higher mean BMI and a faster rate of increase than those from a non-manual background.	childhood factors was independent of adult social factors (Hardy). **Authors' conclusions:** Childhood relative weight and childhood social class were shown to have an effect on BMI in adult life and change in BMI from ages 20 to 43 years, even after adjustment for adult SES and education. The effect of social class on adult obesity differed according to the stage in the life course at which social class was measured, and gender. Childhood circumstances had enduring influences on adult obesity.
CARDIA (Coronary Artery Risk	CARDIA is a population based	**Year of baseline survey:** 1985–86	**Attrition:** Baseline data were collected on 51% of eligible persons contacted. Overall retention rates were 90% at 2 years, 86% at 5 years, 81% at 7 years, 79%	All analyses were **adjusted for**:

Development in Young Adults) Prospective cohort 2+ **Aim:** To estimate the change in BMI over 10 years in a cohort of young US men and women, and assess differences by a range of variables. Lewis 2000 Black and minority ethnic group [BMEG]-based on 10-year follow-up data) Pereira 2005 Fast Food – based on 15 year follow-up data. Sternfeld 1998 PA – based on 7-year follow-up data of selected individuals who completed a treadmill test at	prospective study of 5,115 African American and White men and women in the USA aged 18–30 years at baseline. Study population was balanced on: Age (45% 18–24 years) Sex (46% men) Ethnicity (52% African American) **Baseline weight (kg) as mean (SD) and overweight (%):** AAW: 69.5 (18.3) kg, 44.7% WW: 63.1 (12.8) kg, 22.1% AAM: 77.5 (15.6) kg, 36.9% WM: 77.1 (12.6) kg, 12.6%	**Duration of follow-up**: Ongoing. **Outcome variable**: measured height and weight (and % overweight) at baseline and again at 2, 5, 7, 10 and 15 years), and waist-to-hip ratio. Self-reported or measured variables: • Age • Education • Smoking status • CARDIA PA history questionnaire • Physical fitness (treadmill test, only assessed in selected subsample) • CARDIA dietary assessment = a structured interview (was not done at year 2 follow up) and CARDIA diet history. • Parental fatness and education were derived from self and interviewer-administered questions	at 10 years, and 74% at 15 years. **Association of diet with weight change** (based on 15 year follow-up data)**:** Fast foods were quantified based on eating out occasions at restaurants 'such as McDonalds, Burger King, Wendy's. Arby's. Pizza Hut or Kentucky Fried Chicken'. **Fast food intake** was lowest for WW (about 1.3 times per week) compared with the other race-sex groups. Baseline **fast food frequency** was directly associated with changes in weight in both black ($p = 0.0050$) and white people ($p = 0.0013$). Change in fast-food frequency over 15 years was directly associated with changes in bodyweight in white individuals ($p<0.0001$), with a weaker association recorded in black people ($p=0.1004$). By comparison with average 15-year weight gain in participants with infrequent (less than once a week) fast food restaurant use at baseline and follow up (*n* = 203), those with frequent (more than twice a week) visits to fast food restaurants at baseline and follow up (*n* = 87) gained an extra 4.5 kg weight ($p = 0.0054$) . **Association of physical activity with weight change:** *Note:* analysis based on a selected subgroup (*n* = 1777) who completed a symptom-limited graded treadmill exercise test at baseline and year 7. Decreased fitness during young adulthood is strongly associated with increased weight (correlations ranged from –0.34 in WM to –0.49 in WW). Decreased PA was moderately associated with increased weight in WM and BW (correlations –0.13 and –0.15, respectively). Analysis by baseline physical fitness and PA was not presented. **Association of other factors with weight change:** *BMEG (based on 10-year follow-up):* Weight gain 0.96 kg/year (95% CI 0.79, 1.13) in AAW; 0.55 kg/year (95% CI 0.41, 0.69) in WW. *Pregnancy (based on 5 year follow-up of 2788 women at baseline):* Primiparous within both race groups gained 2 or 3 kg more weight during the 5-year period than did nulliparous. Primiparous also had greater increases in waist-to-hip ratio that were independent of weight gain.	Age; Education; Smoking status. Also **adjusted for** PA in analysis. AAW: African American Women WW: White Women AAM: African American Men WM: White Men Overweight was defined as BMI >25.0 kg/m^2.

baseline and 7 years. Smith 1994 Pregnancy – based on 5-year follow-up. Greenlund 1996**;** To assess whether parental educational attainment, parental body shape, and offspring's education were associated with BMI and change in BMI over 7 years		**Statistical analysis**: Various, but all used some form of regression analysis. Women who remained nulliparous (*n* = 925) at 5 years were compared with women who had a single pregnancy and who were at least 12 months postpartum at 5 years.	Multipara did not differ from nulliparous in adiposity change in either race group. *Pregnancy – Black and ethnic minority groups:* At each level of parity, Black women demonstrated greater adverse changes in adiposity than did White women. In conclusion: women experience modest but adverse increases in body weight and fat distribution after a first pregnancy and that these changes are persistent. **Association of other factors with weight change:** (education/body size) **Parental education:** With adjustments for major independent variables, significant associations between fathers educational level and participants baseline BMI were observed among Black men and White women. Father's educational level was associated with a 7-year difference in BMI for White women only. Further adjustment for smoking, alcohol consumption, and PA yielded similar results. In analysis adjusted for age only, father's educational level was also associated with baseline BMI among Black women. In similar models in which father's educational level was replaced by mother's education, only the association with a 7-year change in BMI was significant among White women. **Parental body size:** Father's body size was positively associated with BMI among Black men, White men and White women. Trends were similar in analyses adjusted for age only and analyses adjusted for other lifestyle factors. Mother's body size was positively associated with BMI among all four race-sex groups, and with a change in BMI among White women. When adjusted for age only, a positive association with change in BMI among Black men and Black women was also observed. When adjusted for smoking, alcohol consumption and PA level, results were similar.	

			Participant education: Those participants with the highest education had the lowest BMI and change in BMI over 7 years.	
Wagner 2004 Prospective cohort 2+ PRIME Study **Aim:** To examine the influence of PA on change in BMI (and waist) in middle-aged men over a 5-year period, with special regard to moderate-intensity activities.	Data for this study were collected as part of the PRIME Study (arisen out of the MONICA study). Total *n* = 8069. A cohort of 8865 men aged 50–59 years from centres in France and Northern Ireland. Weight data were missing for 796 of these men at 5 years. No data on ethnicity presented in this paper. **Exclusion criteria:** History of coronary heart disease, diagnosis of cancer during follow-up. **Baseline BMI, mean (SD):**	**Year of baseline survey:** 1991–93. **Duration of follow-up**: 5 years. **Outcome variable**: BMI. **Self-reported or measured weight:** Measured at baseline, but self-reported at yearly follow-ups. **Statistical analysis**: Multiple linear regression.	**Attrition:** 90% of those who took part in the study in 1991–93 were included in the analysis at 5 years. **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** Change in BMI was inversely associated with PA expenditure spent in getting to work, and the practice of high-intensity (> 6 METs) recreational activities. Men who regularly spent more than 10 MET hours per week on walking or cycling to work had a mean change in BMI 0.06 kg/m^2 lower than those who expended less than 10 MET hours per week on walking or cycling to work. In the subgroup of men who did not perform high intensity activities, the level of recreational PA expended was *not* associated with weight gain. **Association of other factors with weight change:** No analysis. **Summary:** In middle-aged men, PA of moderate intensity, which are probably easier to promote than more vigorous activities and, in particular, a more current daily activity, walking or cycling to work, may have a more favourable effect on weight gain.	**Adjusted for**: Covariates: Educational level; Smoking status; Alcohol consumption; Centre; Age; Marital status; Pursuit of weight-control diet; SES. *Note*: Lengthy details about how PA was categorised and calculated are in the paper. PA – the MOSPA-Q was used to assess the amount of PA performed during the previous year, according to the category of PA (occupational activity, walking or cycling to and from work, and leisure-time activities)

	26.6 (3.4) kg/m^2			
Heitmann 1995 Prospective cohort 2+ **Aim:** To examine the influence of dietary fat on changes in BMI in adult women at 6 years while taking into account their predisposition to obesity, total daily energy intake, leisure PA, smoking status, and menopausal status. **Ow/Op:** Overweight women (BMI > 25 kg/m^2) with at least one obese parent; *n* = 56. **Ow/Np:** Overweight women (BMI > 25 kg/m^2) with non-obese parents; *n* = 53. **Nw/Op:** Ideal weight women	*n* for this analysis = 308. Data for this study were collected on a subset of 437 women, selected randomly at baseline from a larger population sample of 1462 women aged 38, 40, 50, 54 or 60 years living in Gothenburg, Sweden. At baseline in 1968–69, 418 of these women participated in a diet history interview, a 24-hour dietary recall, and a health examination. Six and 12 years later, in 1974–75 and 1980–81, all participants were invited to follow-up health examinations. The second examination (at 6 years) was attended by 373	**Year of baseline survey:** 1968–69 **Duration of follow-up**: 6 years. **Outcome variable**: BMI (measured height and weight). **Self-reported or measured weight**: Measured **Statistical analysis**: The relation between change in BMI over 6 years and fat intake at baseline within the four groups of women was assessed by regression. In the regression analysis, a number of covariates at baseline were included; age, BMI, total daily energy intake, LTPA, smoking habits. Menopausal changes between baseline and 6 years were included as covariates.	**Attrition:** 70% **Association of diet with weight change:** *Summary:* High dietary fat (>40% total daily energy intake) was significantly associated with a 6-year gain in BMI only among women predisposed to obesity (*p* = 0.003), but not among obese women with lean parents, or lean women with or without obese parents. *Note*: Only six Ow/Op women had fat intakes >40% total daily energy intake. **Association of physical activity with BMI change:** No analysis. **Association of other factors with weight change**: No analysis.	**Adjusted for:** Covariates stated in statistical analysis.

(BMI <25 kg/m^2) with at least one obese parent; *n* = 87. **Nw/Np:** Ideal weight women (BMI <25 kg/m^2) with non-obese parents; *n* = 112.	(89%) of the 418 women, and the third examination (at 12 years) was attended by 324 (78%) of the 418 women. At the12-year follow up, 316 of the 324 women answered questions about the fatness of their mother and father. For this paper, only women who provided baseline data, data on height and weight at 6 years, and answered questions about the fatness of their mother and father at 12 years were included. Of the potential 316 women who could be included in this analysis, eight were excluded (had cancer at baseline).			

	Women already overweight with one or more obese parent(s) were considered to be predisposed to obesity. No data on ethnicity, education or income presented in this paper. **Exclusion criteria:** Pre-existing major chronic diseases at baseline (stroke, myocardial infarction, diabetes, cancer) **Baseline BMI (kg/m^2), mean (SD):** Ow/Op (*n* = 56) 29.6 (4.0) Ow/Np (*n* = 53) 28.0 (2.7) Nw/Op (*n* = 87) 22.4 (1.7) Nw/Np (*n* = 112) 21.9 (1.9)			
Sundquist 1998 Prospective	1972 women and 1871 men (*n* = 3843) aged	**Year of baseline survey:** 1980/81	**Attrition:** 17%	None stated **Author's**

cohort 2+ **Aim:** To assess the influence of ethnicity (country of birth) and SES on BMI.	between 25–74 years, from Sweden. The subjects were all Swedish residents either born in Sweden, Finalnd, Western Europe and Western Europe. **Baseline BMI:** Baseline mean BMI for male subjects: 25–34 years: 23.5 kg/m^2 35–44 years: 24.4 kg/m^2 45–54 years: 25.2 kg/m^2 55–64 years: 25.3 kg/m^2 65–74 years: 25.4 kg/m^2 Baseline mean BMI for female subjects: 25–34 years: 21.7 kg/m^2 35–44 years: 22.7 kg/m^2 45–54 years: 24.1 kg/m^2 55–64 years: 24.9 kg/m^2 65–74 years:	**Duration of follow-up**: 8 years. **Outcome variable**: BMI. **Self-reported or measured weight**: Not stated. **Statistical analysis**: Pearsons correlation coefficient was used to calculate the correlation between BMI in 1980–81 and 1988–89.	**Weight changes:** The mean BMI increased significantly between 1980–81 and 1988–89 in both men and women in all age groups, apart from the age group 65–74 years where BMI decreased. **Association of other factors with weight change:** *Socioeconomic status:* People of a low level of education had the highest BMI. All educational groups increased their BMI over 8 years with the exception of poorly educated men. Less educated individuals increased their mean BMI by 0.25 kg/m^2 less than highly educated people (reference group), based on educational level 1988–89. Men and women who were single in 1980–81 and married in 1988–89 increased their BMI by 0.37 and 0.65 kg/m^2 more than those who were married at both times. Poor health status was related to a decreased BMI among men but not among women. Males who reported good health status in 1980–81 and bad health status at follow up decreased their BMI by 0.28 kg/m^2 less than males who were in good health status at baseline and follow-up. *Ethnicity:* The different ethnic groups had similar changes in BMI changes in BMI from 1980–81 to 1988–89. The BMI of men and women born in Sweden and other western countries and of women born in Finland increased significantly through the 1980s. The BMI of southern European Men increased from 25.5 to 27.0 kg/m^2 during the same period. Southern European men had a higher BMI compared with the reference group; this was the same for southern European women, but no significantly so. Finnish women had an increased BMI on adjusting for the age, smoking, exercise, education, marital status, health status and time. *Smoking:* Male smokers had an increased BMI compared with those who had never smoked. Female smokers had a much lower BMI compared with those who have never smoked. *Physical activity:* Not taking exercise was associated with an increased BMI for men and women.	**conclusions:** SES and ethnicity are two separate independent factors that influence BMI in males and females. Former smokers had a larger increase in BMI than those who have never smoked. Males who quit doing exercise had a larger increase in BMI than regular exercisers.

	25.1 kg/m^2		Males taking exercise in 1980–81 but not at follow up increased their BMI by 0.28 kg/m^2 more than the reference group (people taking exercise at baseline and follow-up). Females who did not take exercise on both occasions decreased their BMI by 0.37 kg/m^2.	
Tiggemann 2004 Prospective cohort 2+ **Aim:** To assess dietary restraint and self-esteem as predictors of weight change over 8 years.	*n* = 77 young adults (19 men, 58 women), mean age 25 years, all undergraduate first-year students at University in Australia. No data on ethnicity, education or income is presented in this paper. **Exclusion criteria:** Pregnancy, medical condition that significantly affected weight **Baseline weight (kg), mean (SD):** Men: 75.2 (6.2) Women: 58.0 (7.0)	**Year of baseline survey:** Not reported. **Duration of follow-up**: 8 years. **Outcome variable**: BMI. **Self-reported or measured weight**: Self-reported. **Statistical analysis**: Hierarchical multiple regression.	**Attrition:** 60% of those who took part in the study at baseline (*n* = 166). **Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** Neither dietary restraint nor self-esteem predicted weight change on its own in men or women, but their interaction did in women. The women who put on the most weight were those low or high in both dietary restraint and self-esteem. The group who put on the least weight were those low in dietary restraint and high in self-esteem.	None stated.
van Lenthe 2000	*n* = 767 young Dutch adults (362 men, 405	**Year of baseline survey:** 1991	**Attrition:** Difficult to assess.	None stated.

Prospective cohort 2+ GLOBE study **Aim:** To assess socio-demographic variables as predictors of weight change over 6 years in a group of young Dutch adults.	women), age 20–49 years at baseline. **Exclusion criteria:** Missing information, serious heart problem, cancer, and diabetes. **Baseline BMI (kg/m^2), mean (SD):** Men: 24.3 (2.9) Women: 23.0 (3.3)	**Duration of follow-up**: 6 years. **Outcome variable**: BMI. **Self-reported or measured weight:** Self-reported. **Statistical analysis:** Multivariate linear regression.	**Association of diet with weight change:** No analysis. **Association of physical activity with weight change:** No analysis. **Association of other factors with weight change:** Despite significant associations between BMI and SES at baseline, no statistically significant associations were found between SES variables and the 6-year change in BMI.	Author's conclusions: SES was not associated with the 6-year change in BMI.

MEDLINE SEARCH STRATEGY

1. weight gain/ph
2. (prevent$ adj3 weight gain).ti,ab
3. or/1–3
4. limit 4 to yr=1990-2005
5. limit 5 to English
6. animal/
7. human/
8. 7 not (7 and 8)
9. 6 not 9

MEDLINE SEARCH STRATEGY FOR UPDATE SEARCH TO 1ST DECEMBER 2005

1. Weight gain.tw
2. Cohort.tw
3. 1 and 2
4. Limit 3 to yr=2005

Line 2 of the original search strategy (see below) was omitted in order to widen the search in an attempt to capture all key cohorts. Lines 5-9 of the original search strategy were unnecessary given the relatively small number of hits for the update.

DATA SOURCES

The following information sources were searched:

AMED
ASSIA
British Nursing Index
CAB Abstracts
CENTRAL (Cochrane Controlled Trials Register)
CINAHL
Clinical Evidence - http://www.clinicalevidence.org
Cochrane Database of Systematic Reviews
CRD (EED database) http://www.york.ac.uk/inst/crd
DARE
Embase
EPPI-Centre - http://eppi.ioe.ac.uk/
ERIC
Food Standards Agency - http://www.food.gov.uk/science/research/
HDA Evidence Base - http://www.hda-online.org.uk/html/research/effectiveness.html
Health Evidence Bulletins – Wales - http://hebw.cf.ac.uk
HealthPromis
IUHPE (International Union for Health Promotion and Education) - http://www.iuhpe.nyu.edu/pubs/index.html
Medline
NCCHTA - http://www.ncchta.org
NICE – www.nice.org.uk
Public Health Effectiveness (Hamilton, Ontario) - http://www.health.hamilton-went.on.ca/CSCARB/EPHPP/ephpp.htm
PsycINFO
SIGN – http://www.sign.ac.uk
Social Science Citation Index (equiv. to Current Contents)
Sociological Abstracts
Sport Discus

The electronic search strategies were developed in Medline and adapted for use with the other information sources.

EXCLUDED REFERENCES

Excluded references not meet all review parameters. The main reason for exclusion was that the study was not a prospective cohort with at least 12 months duration or it was a non-systematic review.

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Appendix 5

Raising awareness of what constitutes a healthy weight range and the need to stay within such a range

EVIDENCE SUMMARY TABLES

EVIDENCE TABLE 1: **RAISING AWARENESS OF WHAT CONSTITUTES A HEALTHY WEIGHT RANGE AND THE NEED TO STAY WITHIN SUCH A RANGE**

First author	**Study design**	**Research type**	**Research quality**	**Study population**	**Research question and design** (include power calculation if available)	**Length of follow-up**	**Main results** (include effect size(s)/confidence intervals for each outcome if available)	**Confounders** (potential sources of bias)**/comments**
Evidence of efficacy (internal validity) for weight maintenance/reduction								
O'Loughlin et al. 1998	RCT	1	+	Intervention *n* = 94 Control *n* = 94 Data based on completers (intervention = 82, control = 75) **Age:** Intervention group: Female: 67.1% Age: 39.2 years ± 14.5 Control group: Female: 72.0% Age: 37.0 ± 12.6 years **Education attainment (%):** Intervention group:	This RCT investigated the impact of a low intensity, healthy weight intervention in low-income adult volunteers from inner city St Henri, Canada. Pamphlets (18 four-page, two-colour, glossy and pre-punched, two or three per week) were distributed to the	**Intervention:** 8 weeks. **Follow-up:** 10 weeks (2 weeks after end of intervention).	816 people were contacted but 188 (23%) volunteered to receive the pamphlets. Seventy-three participants were recruited from the Awareness and Participation Survey (13.6%); 115 participants were recruited from the 279 households contacted in the supplemental survey (41.2%). Eighty-two of 94 intervention participants (87.2%) and 75 of 94 control participants (79.8%) completed both interviews. The intervention had no effect on body mass index (BMI).	Short follow -up period. Data were self-reported. Use of telephone interviews (minimal face to face contact) possibility of bias related to social desirability. **Generalisability:** Unclear, low-income low-literacy inner city population of

				Less than secondary: 17.1 Completed secondary: 39.0 Completed university: 43.9 Control group: Less than secondary: 17.8 Completed secondary: 38.4 Completed university: 43.8 **Main activity in past 12 months (%):** Intervention group: Work: 54.9 Looking for work: 3.7 Student: 15.9 Retired: 13.4 Homemaker: 7.3 Other: 4.9 Control group: Work: 63.5 Looking for work: 2.7 Student: 17.6 Retired: 5.4 Homemaker: 6.8 Other: 4.1 **Marital status:** Intervention group: Married: 41.5% Single (never married): 37.8% Separated/widowed/Divorced: 20.7***%*** Control group: Married 38.7%	participants' homes for an 8-week period. The pamphlets focussed on increasing awareness of healthy weight ranges, increasing self-acceptance and satisfaction with weight, and improving eating habits, while not putting much emphasis on dieting and weight loss. Pamphlets designed to be highly accessible to persons of low literacy and based on Canadian recommendation s 1988 for healthy weight, pamphlets were piloted. Recruited during October 1995 Awareness and Participation		**Awareness:** Intervention participants remembered receiving 13.1 (± 4) of 18 pamphlets, 89.6% had read one or more and 90.4% found the information useful. Participants in the intervention group were 3.7 times more likely than participants in the control group to report they knew how to control their weight. Participants in the intervention group were also less likely to report they were too heavy (odds ratio [OR] 0.3).	French/English-speaking Canadians.

				Single (never married) 48.0% Separated/widowed/Divorced: 13.3% **Income sufficiency (%):** Intervention: Insufficient: 12.2 Sufficient: 22.0 High: 45.1 Missing: 20.7 Control group: Insufficient: 17.3 Sufficient: 22.7 High: 46.7 Missing: 13.3 Volunteers more likely than non-volunteers to be female, younger and obese and less likely to be in pre-contemplation stage of readiness to improve eating habits. Adults were randomly selected from households which were randomly selected from residential telephone subscriber lists for the main survey; additional survey households also randomly selected but individual who answered the phone was asked to identify one adult member who might want to participate in the trial. All participants then 'randomly	telephone survey of adults in St Henri (plus a supplemental sample from telephone subscriber list) one of three annual surveys to monitor community penetration of Coeur en sante St Henri activities (multifactorial community heart health promotion programme in Montreal). **Providers of intervention:** Research staff.			

				allocated' to intervention or control group.				
Wardle et al. 2001; Miles et al. 2001	Before and after study design with one cross-sectional survey by the Office of National Statistics (ONS) and pre-post survey of random sample of respondents.	2	+	ONS survey: Total sample *n* = 1894 Men *n* = 938 Women *n* = 956; All adults but targeted more to overweight and obese adults. Age (years) **Women (%) Men (%)** 16–24 11.2 16.5 25–34 18.1 16.3 35–44 20.3 18.8 45–54 16.8 18.4 55–64 13.5 11.3 65 +0.1 18.7 Ethnicity **Women (%) Men (%)** White 95.1 94.7 Non-White 4.9 5.3 Maritial status % **Women(%) Men (%)** Single 15.9 24.4 Married/ cohabiting 63 66.7 Separated/ divorced/ widowed 21.1 8.9 Occupational social class	The study's primary objective was to evaluate the BBC's national 'Fighting Fat, Fighting Fit' (FFFF) campaign's success in achieving public awareness of the need for obesity prevention and putting over its message of healthy eating and increased physical activity (PA). The campaign aimed to stimulate behaviour change and was based on behaviour change theories such as Social Learning Theory and the Health Belief Model. Main message of campaign was that weight problems are	Campaign was for 7 weeks. General population survey by ONS: 3 months after the campaign finished. (March 1999). Registrants survey (random sample of 6000) where pre-campaign baseline behaviour assessed retrospectively 5 weeks into the 7-week campaign and again 5 months later.	70% (*n* = 1894 interviews) of random sample of ONS survey participated in telephone interview; 0.9% sent for registration pack; 0.2% registered with scheme. **Registrants survey:** 14% of those who requested an information pack returned their registration card, 61% returned the baseline questionnaire, 58% of people who completed baseline questionnaire also completed 5-month follow-up questionnaire (35% of original random sample of 6000). Non-completion rate of activity measure was 12% so results here should be treated with caution. Adults from higher socio-economic groups not only more likely to complete baseline questionnaire but complete follow-up questionnaire (suggesting more active participation in campaign). **Office of National Statistics survey:** 56.6% (*n* = 1072) had heard of the campaign, 29% recalled watching one of the television	Self-reported data. Generalisation of the results is limited due to the 70% response rate for ONS survey and less than 1% registered and of these 6000 surveyed in registrants survey.

				Women (%) Men (%) 1 and 2 29.2 40 3NM 35.9 12.2 3M 9.9 29.4 4 and 5 25 18.4 Years of education **Women (%) Men** ≤10 31.3 31.3 11 25.4 29.6 12 11.9 9.6 > 12 31.3 29.4 Campaign registrants survey randomly selected sample of 6000 from 33,474. Evaluation participants were more likely to be female (87%), aged between 25–49 years, have an educational qualification, have a degree, be in paid work, have access to car/van and own their own home – suggesting they came from higher socio-economic status (SES) groups. They were less likely to be smokers, less likely to be classified as vigorous exercisers and more likely to be classified as obese compared with the British adult population.	best tackled with small but permanent changes to diet and exercise rather than short-term dieting to achieve rapid weight loss. The FFFF was promoted over 7 weeks of campaigning during peak and day-time programming across BBC one and two, BBC radio two and local BBC radio programmes and was additionally supported by the BBC FFFF official website, Ceefax, a book, a video, the *Radio Times* and telephone lines that provided further information to the general public. People could write or telephone for an information pack		(TV) programmes and about the same number remembered the campaign involved either healthy eating or being more active. Less than 1% registered to participate in the scheme. Higher levels of awareness, a greater likelihood of watching the programmes and better memory for the messages were found among younger, White, female respondents and those with more years of education. There were no significant regional differences or any differences associated with body weight. People who remembered having seen one of the TV programmes were significantly more likely to recall the lifestyle message independent of demographic predictors indicating TV programmes were effectively transmitting the message. 87% said they were introduced to campaign through TV, 14% by radio. The campaign was effective in reaching its target audience (non-manual and skilled manual aged 21–45 years) as a significantly larger proportion had heard of the campaign compared with those	

					for £2 including self-help guide and three registration cards to return over 5 months to chart progress also money-off vouchers for FFFF book and exercise video up to total of £3, other incentives/prizes such as years free supply of fruit and vegetables. The FFFF campaign aimed to target specifically groups with higher prevalence of obesity (those in socio-economic groups 3M and 4). The crossover between those most likely to be obese and BBCs typical audience was considered to be those in		not in target audience (67% vs. 54%, $p > 0.001$). **Registrants survey:** Average post-campaign weight was 2.3 kg lower for full sample (baseline scores carried forward to follow-up for those who did not complete follow-up questionnaire, $n = 3661$) and 4.2 kg for completers ($n = 2122$, $p > 0.001$) with 44% full sample and 78% completers losing weight. Average BMI remained in the obese category. Predictors of change (completers only): men were more likely to report changes in weight, exercise and fried food intake, deprivation level was associated only with decreases in fried food intake, baseline weight predicted weight loss and positive changes in diet with obese reporting greater changes. Predictors of change (all participants): groups with higher levels of deprivation were less likely to report weight loss or exercise increase, obese did not report greater changes in diet and weight loss and changed less in terms of exercise than normal weight groups.	

					social classes 3NM and 3M aged between 21–45 years (skilled non-manual and manual groups). The generic campaign trail was broadcast on TV and radio late in December 1998 and in early January 1999. Principal TV programmes (with different target audiences) were 'Weight of the Nation', 'Fat Free', 'Fat Files' (Horizon trilogy), and 'Body Spies'. BBC radio had 3-day launch with celebrities, TV chef, health minister and phone-in. FFFF campaign mentioned in 60 magazines, 9 national newspapers and 120 regional		Men, people aged <25 years, low SES and Black and Minority Ethnic Groups (BMEGs) may require specifically targeted campaigns – significantly fewer participants in these groups failed to complete the follow-up (registrants survey).	

					newspapers and articles in national press during 7 weeks about 28 times. **Providers of intervention:** The Health Behaviour Unit, Department Epidemiology and Public Health from University College, London and the BBC Education Department.			
Tudor-Smith et al. 1998	Before and after design but samples are independent (cross-sectional) population surveys with an intervention community and a	2	–	**Geographical area:** Wales, UK and north-east England (reference area). Wales: 1985: *n* = 18538 1990: *n* = 13045 North-east England: 1985: *n* = 1483 1990: *n* = 4534 All participants were aged between 18–64 years No further details	To assess the 5-year effect of an intervention of a community-based demonstration project called ‘Heartbeat Wales’. The main aim of Heartbeat Wales was to help prevent cardiovascular disease in adults (aged 18–64 years) by focussing on modifiable behaviour risks	Cross-sectional survey took place before and after the end of the 5-year intervention in intervention and control community.	In Wales, the response rate for the household interview was 88% in 1985 and 79% in 1990 and the self-completion response to questionnaire was 67% and 61 % respectively. In the reference area the household interview response was 84% in 1985 and 77% in 1990 and the self-completion response was 64% and 61 % respectively. Altogether 31,583 questionnaires (18,538 in 1985 and 13,045 in 1990) were returned over the surveys in Wales, with 6017 (1483 and 4534, respectively) returned in the north-east of	Self-reported data. The sample size at the baseline measurement at baseline in the North East was too small to give sufficient statistical power to detect a net intervention effect. There is evidence of increases in funding for heart health promotion in the reference area and

	matched reference area.				such as smoking, diet and exercise. Two population surveys (multistage cluster sampling) were conducted in the summer and autumn of 1985 and 1990 in nine different districts of Wales and a matched reference area in the North East of England. Sample size in 1985 survey was determined to detect a 5% change in smoking prevalence within each of the 10 strata (two-tailed). In 1990 sample size was increased in reference area. Heart health promotion used public education campaigns alongside policy		England. Positive changes (for health) in behavioural outcomes were observed among the population in Wales, including a reduction in reported smoking prevalence and improvements in dietary choice. There was no net intervention effect for the programme over and above observed change in the reference area. **Percentage point changes 1985–90 (95% confidence intervals [CI]) aged 18–64 years:** BMI at least 24 kg/m^2 for women and 25 kg/m^2 for men, Wales 2.5 (1.0, 4.0) kg/m^2, control 1.1 (–2.9, 5.1) kg/m^2. Positive change in all behaviour indicators except for overweight, 14 of 15 behaviour-change indicators significant in Wales and 9 of 15 significant in control (13 positive changes).	diffusion of other health promotion campaigns (contamination).

					and infrastructure change. TV programmes were especially developed by BBC Wales and HTV. such as ‘Don’t Break Your Heart’, ‘Fit for Life’ and the BBC Diet programme, ‘Quit and Win’, a smoking cessation programme, food labelling and nutrition education with a major grocery retailer, ‘Heartbeat Awards’, a restaurant and canteen scheme to increase the availability of healthy food choices and smoke free areas and ‘Make Health Your Business’, which was a worksite health promotion programme.			

					In the north-east of England (reference area), no additional community heart health promotion was planned though considerable activity did take place, in order to influence people health behaviours in the north-east. **Providers of intervention:** Health promotion Wales and Research Staff.			

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EVIDENCE TABLE 2: RAISING AWARENESS OF WHAT CONSTITUTES A HEALTHY DIET

First author	**Study design**	**Research type**	**ResEarch quality**	**Study population**	**Research question and design** (include power calculation if available)	**Length of follow-up**	**Main results** (include effect size(s)/confidence intervals for each outcome if available)	**Confounders** (potential sources of bias)**/comments**
Evidence of efficacy (internal validity) for dietary outcomes								
O'Loughlin et al. 1998	RCT	1	+	Intervention group *n* = 94 Control group *n* = 94 Data below are based on completers (intervention *n* = 82, control *n* = 75). Intervention group: Female: 67.1% Age: 39.2 ± 14.5 years Control group: Female: 72.0% Age: 37.0 ± 12.6 years See weight outcomes table (Table 1) for more detail .	See weight outcomes table (Table 1) for more detail.	**Intervention:** 8 weeks. **Follow-up:** 10 weeks (2 weeks after end of intervention).	The frequency of consumption of junk food/high-fat food remained stable in control and decreased in the intervention group (*p* = 0.019). Intervention participants reported more improvements in their eating habits than control (*p* = 0.021).	
Departm	CBA	2	+	National evaluation of five-a-day	**Aim:**	One-year	Response rate information not	

ent of Health 2003			/ – * [?]	pilot projects in five areas of the UK. No details provided in the executive summary and none available from project despite two approaches (fiveaday@sh.gsi.gov.uk) by Cardiff.	To assess the feasibility of implementing an area-wide approach to increasing fruit and vegetable consumption by improving access, increasing awareness and consumption. The intervention included action to improve access to fruit and vegetables by retailers, food co-operatives and targeted promotional activities in the community and by primary health care professionals. Interventions provided by community based cross-sectoral teams in each area. **Delivered by:**	intervention with pre- and post-questionnaires.	available. The community initiatives stemmed a fall in fruit and vegetable intake against the national trend. There was a fall in intake in the control group by almost half a portion (although baseline data suggested control group had a higher intake by 1.5 portions compared with intervention sites). Overall the intervention had a positive affect on people with the lowest intakes. Those who ate less than five-a day at baseline increased their intake by one portion over the course of the study. In contrast, those who ate five or more a day at baseline decreased intakes by about one portion per day. **Awareness:** 17% increase in proportion of intervention group who correctly reported that five-a-day was the optimal fruit and vegetable intake compare with 8% in the control group.	

					Higher education researchers. No power calculation.			
Wardle et al. 2001; Miles et al. 2001	Before and after study design with one cross-sectional survey by ONS and pre-post survey of random sample of respondents.	2	+	ONS survey: Total sample n = 1894 Men n = 938 Women n = 956; Age (years) **Women (%) Men (%)** 16–24 11.2 16.5 25–34 18.1 16.3 35–44 20.3 18.8 45–54 16.8 18.4 55–64 13.5 11.3 65 +0.1 18.7 See weight outcomes table (Table 1) for more detail.	The study's primary objective was to evaluate the BBC's national FFFF campaign. See weight outcomes table (Table 1) for more detail.	Campaign was for 7 weeks.	**Registrants survey: values are for full sample, all values in parenthesis are for completers only** Fruit and vegetable intake increased by 0.8 (1.3) portions per day, $p > 0.001$. Percentage eating recommended five portions per day increased by 13% (23%), $p > 0.001$. Number of participants eating fried food less than once per week increased by 16% (28%), $p > 0.001$. Proportion consuming whole milk decreased from 10 to 7% (9 to 4%), $p > 0.001$. Cutting visible fat off meat increased, $p > 0.001$. Snack intake decreased by 3 (5) snacks per week, $p > 0.001$. Number of starch-based meals increased slightly with 4% (6%) changing from eating one or fewer to two or more a day.	

							Number of pats of butter/margarine used decreased by 0.6 (1.3), $p > 0.001$); number of pats of low-fat spread decreased by 0.4 (0.7), $p > 0.001$. **Predictors of change (all participants):** Groups with higher levels of deprivation were less likely to report weight loss or exercise increase, obese did not report greater changes in diet and weight loss and changed less in terms of exercise than normal weight groups.	
Tudor-Smith et al. 1998	Before and after design, but samples are independent (cross-sectional) population surveys with an intervention community and a matched reference	2	–	**Geographical area:** Wales, UK and north-east England (reference area). Wales: 1985: *n* = 18538 1990 *n* = 13045 North-east England: 1985 *n* = 1483 1990 *n* = 4534 All participants were aged between 18–64 years. No further details.	The main objective of the study was to assess the 5-year effect of an intervention of a community-based demonstration project called 'Heartbeat Wales'. See weight outcomes table (Table 1) for more detail.	Cross-sectional survey took place before and after the end of the 5-year intervention in intervention and control community.	Positive changes (for health) in behavioural outcomes were observed among the population in Wales, including a reduction in reported smoking prevalence and improvements in dietary choice. There was no net intervention effect for the programme over and above observed change in the reference area. Percentage point changes 1985–1990 (95% CI) aged 18–64 years: Consume fresh fruit at least 4 days a week: Wales 8.4 (6.7, 10.1), control: 8.6 (3.0, 14.2). Consume green vegetables or	

	area.						salad at least 4 days per week: Wales 7.2 (5.1, 9.3), control 9.4 (2.7, 16.1). Consume fried food cooked in lard or other solid fat at least 2 days per week at home: Wales –18.7 (–16.8, –20.6), control –21.5 (–14.6, –28.4); note that consumption of fried food was significantly lower in Wales than reference area at baseline. Positive change in all behaviour indicators except for overweight, 14 of 15 behaviour change indicators significant in Wales and 9 of 15 significant in control (13 positive changes).	
Van Wechem et al. (1997)	Before and after design but samples are independent (cross-sectional) with an intervention community and a control communi	2	–	*n* = 1000 Control community group *n* = 500 Experimental community group *n* = 500 All participants were from Alkamaar in the Netherlands (intervention) and Gouda in the Netherlands (control). Participants were selected by random sampling from local telephone books. Every subject that was selected were contacted a maximum of five times during weekdays at different times of the day. Household members who	Community-based campaign 'Fat Watch' 1992, primary aim was to reduce fat intake by 10% among the general Dutch population. Within framework of nationwide fat watch campaign (1991–1994). This intervention was used as a pilot study, which looked at the	Not clear but telephone questionnaires were used before (February 1992) and after (December 1992) the campaign so approximately 8 months.	In Alkamaar, 56% of all respondents reported to be aware of a campaign about dietary fat in their community. A significant lower proportion of all respondents in the control community (17%), with exposure to the nationwide Fat Watch campaign only, were aware of the campaign about dietary fat in their community ($p > 0.001$). 43% of respondents in Alkamaar aware of national campaign and in control this was significantly lower at 34% ($p > 0.01$). In Alkamaar of those who were	

	ty.			would be the first ones celebrating their birthday were selected to be interviewed.	effectiveness of strategies and activities, with the hope of applying the campaign to other cities. The intervention conveyed a positive message about a low-fat diet (i.e. a healthy diet) and was put over in a motivating and informing way, which highlighted the positive consequences of low-fat diets and the consequences of a high-fat diet. During the campaign a total of eighty-one activities took place and attempted to communicate the messages of 'Fat Watch'. These activities were aimed mainly at intermediaries		aware of local campaign, 80% had noticed mass media written information, campaign activities which required more active participation by target groups were less noticed; mean appreciation rating of 7 (out of 1–10, with 10 positive) to local campaign among those who were aware. In the post-test no significant difference in actual fat consumption was found between Alkamaar and the control community. In the experimental community, a small but significant decrease (3%) in fat consumption was found in Alkamaar ($p > 0.04$) when pre test results were compared with post-test results, in control community there was no decrease in fat consumption pre- to post-test (28.3 to 28.4). A significant difference at post-test between Alkamaar and the control community was found for self rated dietary fat consumption. In Alkamaar 65% of all respondents rated their fat intake as ' fat' or 'relatively fat', whereas this was 56% in the control community ($p > 0.02$) (i.e. after the campaign self-rated fat consumption was significantly	

					and partly at the local population. The project group, who ran the project, organised 24 activities, which were aimed at various intermediary organisations, such as supermarkets, hotel and catering industry, health units, common welfare workers, educational organisations and several media. The majority of the activities were based on transfer of diverse, mostly written, mass mediated information and interpersonal communication. Research staff provided intervention and assisted intermediaries (e.g.		higher in intervention community) Additionally in the post-test, more respondents in Alkamaar (32%) than in the control community than in the control community (24%) reported that they had tried to lower their dietary fat intake in the past 6 months (*p* > 0.01). There was no significant difference (*p* > 0.05) between the experimental and control group community in the proportion of these respondents that referred to the Fat Watch campaign as a reason for their behavioural change. No significant post-test differences were found between the experimental and the control group with respect to attitude, perceived social support and self-efficacy expectations towards a reduction in fat consumption and intention to buy lower-fat food products. In the post-test, more participants in Alkamaar (20%) than in the control group (12%) showed the intention to eat lower fat food products in the following 6-month period (*p* > 0.01). Of those respondents who intended to eat lower-fat food products,	

					supermarkets, educational organisations, media) to organise local intervention activities.		significantly more respondents in Alkamaar (29%) than in the control group (11%) referred to the Fat Watch campaign as a motive for this intention (*p* > 0.01). This difference was not found among respondents who intended to buy lower-fat food products.	

EVIDENCE TABLE 3: RAISING AWARENESS OF THE NEED TO BE PHYSICALLY ACTIVE

First author	**Study design**	**Research type**	**Research quality**	**Study population**	**Research question and design** (include power calculation if available)	**Length of follow-up**	**Main results** (include effect size(s)/confidence intervals for each outcome if available)	**Confounders** (potential sources of bias)**/comments**
Evidence of efficacy (internal validity) for physical activity outcomes								
Cavill & Bauman 2004	Systematic review, eight studies were before and after studies, seven were controlled CBAs, most studies used repeat cross-	2	++	**Inclusion criteria:** 1) Campaign had to have at least one media element with mass reach. 2) Campaign needed to use the media in a purposive and organised manner to influence awareness/knowledge/saliency/attitudes, beliefs/self-efficacy/intention/behaviour. 3) Campaign had to employ at least a pre-post design using population samples to measure changes brought about as a result of the campaign. 4) There has to be clear PA mass media component to the	Review of 15 mass media campaigns with an explicit focus on PA to explore impact.	Twelve campaigns used random probability samples with the other three using some form of quota sample; response rates varied from 45 to 96%. **Length of intervention/follow-up:** Varied from	Campaigns achieved high recall with a median 70% (range 38% to 97%) of target group aware of the campaign. Important to note that baseline awareness can be as high as 15–20% if no campaign or message exists. Levels of awareness are likely to vary according to type of media used and scale of the campaign – number of campaigns is too limited for conclusions on minimum dose of media needed. Increases in knowledge or attitudes to PA were found among half the campaigns that reported	Authors unable to determine reliably the extent to which many of the studies represented true 'community-wide' campaigns and as a result it is difficult to separate out the effect of the mass media component in addition to any community activity. Important to measure the dose of the intervention as there

	sectional surveys to assess effects, eight used a cohort and four combined both cross-sectional and cohort.			intervention. Sample sizes ranged from 204 to 7097, with a median sample size of 1800 adults surveyed at baseline.		pre-post surveys only a few weeks apart to follow-up of a cohort after 7 years.	this measure (6 of the 15 studies). Impact on behavioural intention is equivocal. All 15 campaigns measured PA levels. Thirteen of the studies evaluated total population identified as the target group at the start of the campaign and among these only five showed significant increase in PA at the population level. Five studies reported an increase in PA levels and ten reported no significant increases in measures of PA. Four studies reported change in PA in motivated subgroups of volunteers and all four studies showed increases in PA. Campaigns increase awareness of the issue of PA but may not have a population level effect on behaviour.	is a strong relationship between amount of media exposure of a campaign message and the resulting level of awareness – the scale of expenditure, media exposure or outputs from the campaigns was unclear in 10 of 15 campaigns studied. Malmgrem 1986 and Miles 2001 were organised by media providers themselves rather than media space purchased at commercial rates. Difficult to ascertain how much attention was paid to the PA component in the five studies that covered factors other than PA (exposure to PA element likely to be lower in multiple-risk factor media campaigns). Many of the included campaigns were

								single events, others were integrated parts of community-wide cardiovascular education, few were sustained and focused PA initiatives over a number of years. Most campaigns measured distal variables (behaviour), which are least likely to change in the short-term, more measurement need of proximal variables (knowledge, etc.).
RESULTS OF INDIVIDUAL STUDIES INCLUDED IN SYSTEMATIC REVIEW								
Meyer (1980) Part of Stanford Heart Disease Preventio n Program me	Quasi-experime ntal, compare d two interventi on groups vs. control with baseline and three annual follow-			Adults aged 35–59 years at high risk of cardiovascular disease in three Californian communities (each approx. *n* = 15,000)	Compared media plus face-to-face (Watsonville) with media only (Watsonville and Gilroy) and control (Tracy). Radio and TV spots; radio and TV programmes; billboards, posters.	3 years.	Watsonville *n* = 605 (73%); Gilroy *n* = 542 (82%); Tracy *n* = 532 (81%); probability samples. No significant increase in metabolic equivalent tasks (METs) score indicator.	

	ups.							
Malmgren & Andersson 1986 'Get fit with *Corren*' (name of newspaper)	Analysis of all registrants reports; follow-up survey of registrants (12 months) and single survey of random sample.			Adult (≥17 years) readers of the *Corrren* newspaper in Linkoping, Sweden.	Newspaper-initiated health information campaign. Fitness tests offered to participants. Analysis of registrant's reports, follow-up survey of registrants (12 months). Single survey of random sample of inhabitants in Linkoping.	Unclear.	All registrants *n* = 2887. 56% sent in one report, 7% sent in all 12. Survey of registrants *n* = 935 (60% response). Random sample of residents in Linkoping *n* = 204 (82% response). 97% inhabitants aware of the campaign (prompted recall), 75% had read about programme. 6% aware of the campaign and follow it fully. Increase in exercise and fitness among those who registered for the campaign and completed fitness test.	
Aaro 1991a	Quasi-experimental, two experimental and one control group, using cohort surveys.			Residents of Oppland County aged 40–54 years. *n* = 1440 per area, (two experimental and one control group).	Cardiovascular disease intervention programme in Oppland County, Norway 1982–84. Described as mass media and community approach, but details not clear. Two experimental and one control group, using cohort surveys.	Unclear.	Response rate 63.1% Average increase of one training session every third week.	
Aaro	Cohort			Adults aged 16–	One-week campaign	Unclear.	Response rate 60%.	

1991b Sogn og Fjordane County campaig n 1983	survey			68 years in Sogn og Fjordane County Western Norway. *n* = 1000	combining community action with mass media. Cohort survey.		64.3% had heard about campaign. Increase in proportion having tried a new activity.	
Booth et al. 1992 'Exercise : make it part of your day'	Pre and post repeat random cross-sectional surveys.			Australian residents aged >15 years.	Cinema commercials, radio and newspaper, linked to community activities such as publicity and events, PA days, competition during heart week. Population samples.	Few weeks.	Response rates vary between 45% and 60% of households = 2426 pre and 2474 post. Unprompted campaign recall 46% pre, 77% post ($p > 0.001$). Non-significant increase in proportion believing that exercise helped a lot in the prevention of heart disease. Significant association between stage of change and pre-post surveys ($p > 0.01$). 3.9% increase in proportion reporting any walking for exercise in the previous 2 weeks.	
Osler & Jesperse n 1993 Slangeru p – a heart healthy town	Quasi experime ntal design comparin g interventi on and control			Adults aged 20–65 years in Slangerup, Denmark. Baseline *n* = 1072 (51% response).	Cinema commercials, radio and newspaper linked to community activities. Strong links to activities such as fitness tests, lectures, heart day.	One-year follow-up.	One-year follow-up *n* = 1196 (59% response). 82% aware of the programme compare with 67% in control area ($p > 0.001$). Health beliefs measured but not specific to PA.	

	areas with two repeat cross-sectional surveys.				Random samples of central person register.		20% considered doing more exercise (17% control). 'Advice from social network and mass media' was related to trying to be more active ($p > 0.001$). 9% participated in local projects. No significant difference in exercise participation between intervention and control.	
Owen et al. 1995 'Exercise : take another step'	Pre- and post-repeat random cross-sectional surveys.			Australian residents aged ≥15 years.	TV adverts, radio public service announcements (PSAs), campaign materials, scripts in national soaps, unpaid media, associated community activity. Community and health agency activities, physician education, serial heart week campaign. Built on previous campaign 1991 (Booth 1992).	Few weeks	Response rates vary between 45% and 60% of households, n = 2584 pre and 2517 post. Unprompted recall 62.5% pre and 73.5% post ($p > 0.001$). No change in intention to exercise. No significant change in walking or inactivity.	
Blake et al. 1987; Luepker et al.	Quasi experimental with three			Sampled from 4,000,000 persons aged 25–74 years resident in six	High-intensity campaign via the mass media linked to community activity	7 years. Half of the sample	Average total survey response rate = 78.7%. n = 6039 at baseline, 67.1%	

1994 Minnesota Heart Health Program	intervention communities and three controls. (i) Repeat cross-sectional surveys. (ii) Cohort surveys. Random samples of 300–500 adults from each of the six communities.			communities in the Upper Midwest, USA. *n* = 6039 at baseline.	and training and education programmes. PA covered in annual 1–3-month concentrated campaigns. Strong community component including health professional education, screening, counselling. Random sample from within cross-sectional sample taken.	followed-up after 2 years, other half after 4 years, and all cohort after 6–7 years.	completed all waves. During one concentrated PA campaign 93% heard of at least one campaign event. Awareness of media not reported for complete programme but 60% of all adults were recruited to the training and education programmes. Single question ‘Are you active in your leisure time?’ showed small increase in proportion physically active at 2 years but most of this was light PA. The longer Minnesota Leisure Time Physical Activity (MLTPA) questionnaire showed decline in PA.	
Young et al. 1996 Stanford five-city community-wide cardiovascular risk reduction project.	Quasi-experimental residents of two intervention communities compare with two			All residents of Monterey and Salinas Counties, California aged 12–74 years.	Print materials, weekly news column, talks, seminars, workshops, segments in TV news and PSAs. Associated worksite and school programmes. Average of nine messages per person per year.	Unclear	(i) Each random sample approx. *n* = 1800 to 2500 response rates for each wave: 65, 70, 65 and 56% (ii) Cohort *n* = 408 men and 499 women. 39% completed all waves. No evidence of significant impact on knowledge attitudes or self-efficacy. No significant differences were	

	control communities and an additional control community for cardiovascular disease morbidity and mortality data. (i) Repeat cross-sectional surveys. (ii) Cohort surveys.				Strong community-based components including talks, seminars, workshops, walking groups, worksite programmes, competitions.		found for the global estimates of PA for women or men between treatment and controls. Increase in number of 'usual activities' compare with control (*p* = 0.014) for independent and 0.001 for cohort samples).	
Wimbush 1998 HEBS [Health Education Board for Scotland] walking campaig	Before and after design. (i) Awareness: 3 × pre-post tracking survey.	2	+	'Fitline' callers *n* = 4036. Adults of target age (30–55 years) in October 1995: *n* = 335 Adults of target age in February 1996: 370	National campaign in Scotland, to increase the number of individuals, aged between 30–55 years of age, who are not regular exercisers to take up walking. 2 × 1 month bursts of	**Length of intervention:** TV advertising: September and October 1995 and March and April 1996. **Length of follow-up:** June 1995–	(i) Men and women 16–74 *n* = 693 (October 1995), 768 (February 1996) 733 (June 1996). Multistage cluster random probability sample, response rates reported between 62–86%. (ii) Adults *n* = 1066 (June 1995), 1085 (June 1996), response rates not given.	Three stages of developmental and pre-testing research reported. At a population level, the campaign had a notable positive impact on knowledge about walking as a form of exercise but

n ‘Walking: take exercise in your stride’	(ii) Impact: 2 × pre-post cross-sectional surveys. (iii) Baseline survey of Fitline callers and follow-up at 10 weeks and 1 year			Adults of target age in June 1996: *n* = 345. All participants were from Scotland. Bias towards lower SES. Female ‘Fitline’ callers: 59% Male ‘Fitline’ callers: 41% *n* = 4036 <16 years: 8% 16–29 years: 26% 30–55 years: 46% >55 years: 20% *n* = 3476 **Housing tenure:** Owner occupied: 61% Rented: 29% Other: 10% *n* = 2828 **Social class:** Manual: 40% Non-manual: 60% *n* = 2042	40 second TV advert. Telephone direct response (Fitline) and information pack, little community activity reported. To assess the actual impact of the campaign on those who actively responded to the walking campaign a baseline survey occurred with all those who telephoned ‘Fitline’ between the 13 September and 25 of October 1995; this accounted for 4036 callers. Two follow-up surveys were carried out with a sub-sample of responders. The baseline had a response rate of between 62–86% and it involved asking questions to participants about their current walking/exercise patterns.	October 1996 (Tracking survey of awareness, October 1995, February 1996 and June 1996; Omnibus survey of knowledge June 1995 and June 1996; Fitline callers survey September/October 1995, January 1996 and September/October 1996).	(iii) Baseline – all Fitline callers, *n* = 4036; 10 weeks *n* = 490, 1 year *n* = 283 (58%). % Agree ‘Walking a mile uses up the same energy as running a mile’: 20% June 1995, 56% June 1996. % Strongly agree, ‘walking is a good form of exercise’: 38% June 1995, 57% June 1996. No change for other statements. Intend to walk more: 55% June 1995, 57% June 1996 (not significant). Population change: days spent walking for 30 min: 4.26 June 1995, 4.13 June 1996 (not significant). Fitline callers 0.5 stage increase in average stage of change, overall shift from the contemplation stage of change (Transtheoretical Model) at baseline towards the ‘action’ stage at the 10-week and 1-year follow-up. In Fitline callers; 48% reported being more physically active, 46% said about the same as before and 7% less physically active at 1 year follow-up. Prompted awareness of HEBS walking campaign – general	had very little impact on walking behaviour. Campaign was efficacious in supporting the exercise behaviour change process among non-regular exercisers in the ‘ contemplation stage’ (of the Transtheoretical Model) through advertising of a free direct response telephone service but response was higher among non-manual, owner-occupier groups and those who were already regular exercisers. Fitline had less appeal to lower SES groups despite higher awareness levels.

					Providers of intervention: Health Education Board for Scotland. Staff from the Centre for Leisure Research at Heriott Watt University, Edinburgh Staff from the Centre for Social Marketing at Strathclyde University, Glasgow		population adults. Awareness of the "Gavin TV advertisement": October 95 = 70%, February 96 = 54%, June 96 = 69% Awarenes of Local radio features 8%, 13%, 21% Awareness of Fitline October 95 = 5%, February 96 = 16% but only 5% of these respondents used the service. This level of use indicates 0.1% coverage at the beginning of the campaign rising to 1% 4 months later.*n* = 693 in October 1995, 768 in February 1996 and 733 in June 1996 Prompted awareness of HEBs walking campaign – Target group (aged 30–55 years). Prompted awareness of Gavin TV advertisement October 1995 = 67%, February 1996 = 54%, June 1996 = 69% Prompted awareness of Local radio features 8%, 11%, 21% Prompted awareness of Fitline October 1995 = 5%, February 1996 = 16% *n* = 335 in October 95, 370 in February 96 and 345 in June 96.	
Miles et al. 2001; Wardle et	Before and after study	2	+	**Office of National Statistics survey:** Total sample	The study's primary objective was to evaluate the BBC's	Campaign was for 7 weeks.	0.9% sent for registration pack; 0.2% registered with scheme.	Self-reported data. Generalisation of the

al. 2001 BBC 'Fighting fat fighting fit' campaign	design with one cross-sectional survey by ONS and pre-post survey of random sample of respondents.			*n* = 1894 Men *n* = 938 Women *n* = 956 All adults but targeted more to overweight and obese adults See weight outcomes table (Table 1) for more detail.	national FFFF campaign. Seven weeks of peak and daytime programming across BBC TV and radio.		Significant increases in brisk walking, moderate activity and vigorous activity, overall 39% (74%) increased their activity levels. Total number of min per week spent in activity increased by 94 (181) min per week, *p* > 0.001. % Classified as sedentary reduced from 34 to 25% (35 to 17%). % Doing irregular moderate exercise decreased from 36% to 29% (36% to 22%). % Regular moderate exercise increased from 29 to 45% (29 to 60%). % Vigorous exercise increased from 3 to 6% (2 to 9%). All *p* > 0.001. **Predictors of change (completers only):** Men were more likely to report changes in weight, exercise and fried food intake, deprivation level was associated only with decreases in fried food intake, baseline weight predicted weight loss and positive changes in diet with obese reporting greater changes. Predictors of change (all	results is limited due to the 70% response rate for ONS survey and less than 1% registered and of these 6000 surveyed in registrants survey Men, people <25 years, lower SES and BMEGs may require specifically targeted campaigns (registrants survey).

							participants): groups with higher levels of deprivation were less likely to report weight loss or exercise increase, obese did not report greater changes in diet and weight loss and changed less in terms of exercise than normal weight groups.	
Hillsdon et al. 2001	Before and after study	2	+	*n* = 6711 Completers *n* = 3189 Non-completers *n* = 3522 All participants were from England, aimed at young women 16–24 years, men 45–55 years, adults ≥50 years. 42.5% of completers were males. 44.7% of non completers were male. 43.6% of the total sample were male. **Social grade %** AB 20.3	Based on concept of social marketing using advertising, public relations and publicity. ACTIVE FOR LIFE campaign was a 3-year health promotion mass-media campaign run in England and commissioned by Department of Health and run by Health Education Authority, aimed to increase knowledge and acceptability of 5 sessions, 30 min each of moderate intensity PA per week (walking, cycling, swimming, dancing, heavy gardening and housework); integrated with professional education and support.	2 years (1995–97).	12,907 addresses were identified and 6711 baseline interviews were conducted (52% response rate). In phase 2 in 1996, 4268 interviews were conducted (64% of baseline) and 3189 in 1997 (48% baseline). 38% of all the participants were aware of the campaign (unprompted and prompted awareness combined), assessed six to eight months after the main period of advertising. 5.5% could recall key images of the TV campaign unprompted with a further 32% recognising still photographs taken from the TV advertisement. Greatest awareness was in those aged 16–24 years (65%) and lowest awareness in those aged 65–74 years (25%). Men were more aware than women as were those with children living at home and those in lower social grades. Participants who were more ready to adopt regular PA and who were already active at a vigorous level were more aware of the campaign than those who were less ready and less active. Those aware of the	Media budget £2 million. Linked to professional education programme. Developmental research and pre-testing. 52% response rate may have lead to an under represented sample. No published reliability and reliability studies exist for the PA questionnaire used in the study. Results of the study may have been confounded by secular trends, e.g. between 1994 and

				C1 30.1 C2 20.8 DE 28.7 Car use 72.1% Non-White 5.4% Home ownership (%) 73 Children (% yes) 30.3 Non-completers were younger; fewer were in social grade AB, owned their own home or car. Fewer had children or perceived that PA would lead to physiological benefits. More were non-White.	Campaign resources, which included posters, leaflets, postcards, two websites and other promotional items were all implemented and developed to promote the main campaign message to specific priority groups. These groups included young women aged between 16–24 years, middle-aged men aged 45–55 years, men and women aged 50 years. All these groups were targeted in three different phases of the campaign. The first phase of the campaign was a 40 second TV advertisement – 'The thirty minute games'. This emphasised the importance of activities such as walking, gardening and cycling for health and that activity		campaign, when asked at year 1 were already more active at baseline than those not aware of the campaign (suggest active people more likely to recall advertising). The proportion of participants' knowledge about moderate PA recommendations increased by 3.0%. (95% CI 1.4, 4.5) between baseline and year 2 and 3.7% (95% CI 2.1, 5.3) between baseline and year 3. No significant difference in knowledge by awareness of the campaign advertising suggesting if campaign did produce these increases in knowledge it was through element other than TV advertisements. (Assessed as knowledgeable if could recall all three elements of a complicated message.) Changes in proportion of participants who knew about recommendations were higher in women, older age group and social grades C2/DE. No significant differences in PA levels at baseline and 1-year follow-up, but at year 2 there were 8.8% fewer people active at a vigorous level and 6.8% more people classified as sedentary. The change in proportion of active people between baseline and year 1 was –0.02% (95% CI 2.0, 1.7) and	1998 the number of sedentary men increased by 5% and the number of women by 6%, while those categorised as physically active remained virtually unchanged.

					should be done for 30 min. It was aired over a 6-week period in the spring of 1996 and it targeted abroad range of people aged 16–74 years. The second phase of the campaign began in 1997 and was aimed specifically at men and women aged >50 years. The TV advertisement was repeated in July 1997 but this phase also included campaigns in tabloid newspapers aimed at middle-aged men. The third and final phase of the campaign took place in 1998 and was aimed at young women aged 16–24 years and used advertisements placed in women's magazines. In addition, two sub-campaigns communicated campaign messages to groups that were		between baseline and year 2 was –9.8% (95% CI –7.9, –11.7). 21% increase in number of people active at recommended levels at year 1, in those not active at baseline, along with 46% of people who ceased being active at this level between baseline and year 1 suggest there was a regression to the mean (demonstrates importance of control group). 1.3% decrease in 'readiness to change' score, participants who were aware of campaign were more ready to take up PA than those not aware (*p* > 0.05).	

					defined as having particular access or communication needs: people from BMEGs and people with disabilities. These were highly targeted by advertising in specialised media or through joint promotions with ethnic minority and disability organisations. A national sample of 3189 adults, aged between 16–74 years was used to assess the impact of the campaign. Multi-stage cluster random probability design used with Postcode Address File for England to get representative sample of adults aged >16 years. Thirty-minute interview conducted in the home, baseline data in September and November 1995 and follow-up data in			

					same months in 1996 and 1997. **Providers of intervention:** The Health Education Authority and the research unit at the London school of Hygiene and Tropical Medicine			
Bauman et al. 2001 Exercise; you only have to take it regularly not seriously.	Quasi-experimental design using: (i) cohort; (ii) independent cross-sectional samples, representative population surveys, before and after the campaign; (iii) control survey in			Adults aged 25–60 years in New South Wales Australia who were 'motivated but insufficiently active'.	Two × 15 second TV advertisements, print media advertisements and inserts, phone line, campaign materials. Community level support offered including toll-free phone line; local level and regional initiatives and events, physician education. Extensive formative qualitative focus group research.	Unclear.	(i) Cohort, n = 1185 (response rate = 87%), baseline n = 2009 (response rate 83%), follow-up, n = 1700 (response rate 80.6%). (ii) Control baseline n = 3006 (response rate 81.5%), follow-up n = 2253 (response rate 80.3%), random probability samples of population. Unprompted recall increased from 2.1 to 20.9% ($p > 0.001$), prompted recall increased from 12.9 to 50.7% ($p > 0.0001$); no change in comparison region (rest of country; prompted recall 14% pre to 16% post). Knowledge of appropriate PA increased significantly in the campaign state (four items used). Intention to be more active showed no change in any group.	Media budget AUD$7,000,000.

	non-campaign states.						26.7% of target group (motivated but insufficiently active) increased their activity to above the recommended thresholds (five times per week for 30 min) (*p* > 0.01).	
Reger et al. 2002 'Wheeling Walks'	CBA Quasi experimental; compared intervention in Wheeling with control town, cohort design using surveys and observational measures (trail use)	2	++	Intervention community *n* = 719. Control community *n* = 753 Intervention group: Female: 67.5% Age (mean): 57.4 years Control group: Female: 68.5% Age (mean): 57.2 years Intervention group: Income >US$30,000: 40.6% College graduates: 29.5% Married: 60.2% Estimated BMI: 28.0 kg/m^2 Control group: Income >US$30,000: 44.6%	The pilot study, which was called 'Wheeling Walks' had two main aims: 1) effect a 10% increase in the proportion that meet the Centers for Disease Control (CDC)/American College of Sports Medicine (ACSM)/Surgeon General standard for regular moderate intensity walking; and 2) effect a 15% forward movement one or more stages in Transtheoretical Model stage of change for regular moderate intensity walking. The intervention took place in the city of Wheeling, West Virginia, USA, and was primarily aimed	Length of intervention: 8 weeks (April 2001 – June 2001). Length of follow-up: post-tests occurred immediately after the end of the 8-week intervention period.	517 of the 719 (72%) of the respondents in the intervention group and 571 of the 753 (76%) in the control group completed the baseline and follow-up survey. Post-test surveys were successfully completed with 69 and 74% of the sedentary adults in the intervention community and 252 in the comparison community. Behaviour observation showed a 23% increase in the number of walkers in the intervention community versus no change in the comparison community (OR 1.31; 95% CI 1.14, 1.50). Thirty-two percent of the baseline sedentary population in the intervention community reported meeting the CDC/ACSM/Surgeon General recommendation for moderate-intensity PA by walking at least 30 min at least five times per week vs. 18.0% in the comparison community (OR 2.12; 95% CI 1.41, 2.24).	Messages were pretested. Poor generalisability because income per capita and educational attainment is lower than in the rest of the USA and heart disease death rates and prevalence of obesity are both 18% higher than the national average in the USA. Short intervention period.

				College graduates: 20.2% Married: 63.5% Estimated BMI: 28.5 kg/m^2	at sedentary and irregularly active adults aged between 50 and 65 years of age. Comparison community was Parkersburg, West Virginia (similar demographics but no overlapping media). The intervention was an 8-week paid media-based community PA campaign using paid advertising, public relations and public health education activities to promote 30 min of moderate intensity walking as a daily activity to people. Applied Theory of Planned Behaviour and social marketing techniques. A Public Relations firm developed two newspaper advertisements, two 30-second TV advertisements and two 60-second radio advertisements.		The intervention community also realised a pre to post increase in positive stage change ($p > 0.001$). **Awareness:** In the intervention community 90% reported hearing about the campaign, 76% saw some or a lot of TV advertisements, 81% saw some or a lot of TV news stories, 32% reported hearing radio advertisements and 5% reported seeing or participating in any of the public health education programmes.	

					Average households exposed to TV campaign 50 times, radio message 70 times and 14 newspaper advertisements were placed in local newspapers over the 8 weeks. Other public relations activities, work-site programmes, website exposure, physicians prescriptions for walking and other public health education programmes were carried out. Telephone survey questionnaire (random digit dialling) at baseline of adults aged 50–65 years and followed up immediately after the 8-week campaign. Telephone survey questionnaire and observation. **Providers of intervention:** Research staff from			

					West Virginia University (college-level research technicians were recruited to observe, count and intercept adult walkers at five predetermined popular walking sites for 2 hours per day for 1 week before and after the intervention). Wheeling-Ohio County Health Department and the local media.			
Renger et al. 2002 Yuma on the move. Tagline 'Think about it. Its your choice to be active'	Before and after design with cross-sectional surveys. Sub-group analysis of 33 who completed pre and post surveys. Separate detailed	2	–	Targeted adults in Yuma, Arizona 1997–99, especially those aged 30–64 years and in pre-contemplation/contemplation stages of change. *n* = 1203 (*n* = 500 for telephone survey, *n* = 703 for written survey). No SES data available, but Yuma county is a rapidly growing area with	The main aim of the study was to develop, implement and evaluate a community-based effort to increase PA. Community members from the Yuma Regional Medical centre and the University of Arizona developed television and worksite media messages, which focussed on the benefits and barriers of PA and on increasing self-	**Telephone interview:** 3 years (1996–1999). **Written survey:** 1 year (1998–99).	Of the 703 respondents to the written survey 84 at baseline and 75 at follow-up were evaluated as respondents who completed survey at both time points were removed and limited to target population – 30–64 years in first two stages of change. Random digit dialling pre-post surveys (*n* = 500 in 1996 and 500 in 1999) response rate not stated. Written surveys to volunteers (created cohort *n* = 33) and cross-sectional samples (*n* = 75) pre *n* = 84 post) of volunteers (convenience sample). 'The media campaign was effective	Formative research with community regarding PA barriers, taskforce developed message a\and used Centers for Disease Control (CDC) resources, other media/poster. Very small sample analysed from written survey. Independent samples at pre- and post-evaluation but a within-participants analysis was done of

	written survey administers at events and health fairs to volunteer completers. Process evaluation of number of campaign posters displayed.			55% of its population <35 years of age and an ethnic distribution that is predominantly Hispanic (48.5%) and White (46.8%).	efficacy. These media messages were developed using and based upon Prochaska's Transtheoretical model and consciousness raising strategy. The task force, which produced the media messages, chose three different methods to deliver the media messages: public service announcements, comic strips and worksite posters. The first comic strip was released in December 1998 in 17 worksite newsletters. The second comic strip was released in October 1999 and was published in five worksite newsletters by 1 December 1999. The first poster was used in January 1999 and 135 posters were displayed at 74 worksites and community buildings.		in changing perceived barriers, perceived benefits and self-efficacy surrounding PA and 'unexpectedly' had a positive effect on changing behaviour (i.e. main purpose was to get people to think about it but some actually changed behaviour).' Mean recall of PA messages on television score increased significantly (only from 30 volunteer responders). Many cited campaign as the message they heard (numbers not further stated). In volunteer samples, knowledge and beliefs assessed, no significant change in ten-item knowledge score, no change in decisional balance score (benefits/barriers to PA). In volunteer samples, increases in self-efficacy reported. The evaluation of the written survey found no significant change in level of activity. Within-subject analysis of 33 participants (took part in baseline and follow-up survey) showed significant change in level of PA from baseline to follow-up $p > 0.002$. Telephone survey showed that 29.8% respondents reported they did not engage in leisure time	33 participants (took part in baseline and follow-up survey) showed significant change in level of PA from baseline to follow-up, $p > 0.002$.

					The second was released in November 1999 with seventy-one posters were on display by 1 December 1999. Posters were put in areas of high traffic as well as other areas where employees may gather. To evaluate the impact of the intervention a telephone interview and a written survey was used. 500 households in Yuma County were contacted by telephone in 1996; the questionnaire consisted of 111 questions, many of which were the same as those used in the Behavioral Risk Factor Surveillance Survey (BRFSS). The telephone interview was repeated in the fall of 1999. The written survey consisted of 11		physical activity (LTPA) in 1997 and in 1999 this was reduced to 25.6%. Corresponding values in Arizona were 33.8% in 1997 and 51.5% in 1999. Analysis of the telephone survey found only one statistically significant change among age categories, with self-reported no LTPA decreasing from 35.6 to 23.1% ($p > 0.05$) amongst women aged 40–64 years.	

					questions was administered to local schools, businesses and at the county fair prior to the media campaign and again administered year later at the same locations.			
INDIVIDUAL STUDIES								
Merom 2005	Before and after study (not controlled)	2	+	Primary school-age children and their parents in New South Wales, Australia.	To describe the reach, participation and support of the New South Wales Walk Safely to School Day (WSTSD). Paid media advertising before the event promoted WSTSD.	One day every year for 4 years	School register: 2001: 496 schools 2002: 717 schools 2003: 708 schools 2004: 751 schools participated in the New South Wales WSTSD (repeat participation over 3 years was low). 53% of all NSW schools registered to participate in one WSTSD and 15% participated for 3 years. Significantly more schools from urban regions participated ($p > 0.05$). School evaluation forms: Only 37% of participating schools returned evaluation – smaller schools had a higher participation rate. 7% schools organised walking related activities, and 28% indicated that promotion of healthy lifestyle was a reason for participating.	Only 37% of participating schools returned evaluation – potential for bias.

							Parent survey: (89% response rate to randomly selected eligible telephone numbers). 53% were aware of WSTSD with main source of information being the school then the media. Relative increase of 31% of children walking attributed to the event. On a population level this equates to an increase prevalence of walking to school of 6.8%. **Author's conclusion:** Stronger interventions required but campaign did result in moderate short-term change.	
O'Loughlin et al. 1998	RCT	1	+	Intervention group *n* = 94 Control group *n* = 94 See weight outcomes table (Table 1) for more detail.	This RCT investigated the impact of a low intensity, healthy weight intervention in low-income adult volunteers from inner city St Henri, Canada.	**Intervention:** 8 weeks. **Follow-up:** 10 weeks (2 weeks after end of intervention).	Intervention participants were 2.7 times more likely than control to change from reporting no exercise at baseline to exercising once or more a week at follow-up.	Short follow-up period. Data were self-reported. Use of telephone interviews (minimal face to face contact) possibility of bias related to social desirability Generalisability unclear, low-income low-literacy inner city

								population of French/English-speaking Canadians.
Huhman et al. 2005	Before and after study (not controlled)	2	+	**Geographical area:** USA *n*= 3120 parent–child dyads All participants were aged between 9 – 13 years of age. Participants were of either Black, Hispanic/Latino, Asian or Native American. No further details.	The intervention aim was to determine the effects of a mass media campaign on PA levels among multi-ethnic children aged 9 to 13 years of age from the USA. Primary aim was to achieve high levels of awareness among the target audience. The VERB campaign combined paid advertisements with school and community promotions and internet activities to encourage children 9–13 years to be physically active every day. Launched in 2002 by CDC, VERB used child-focused commercial marketing methods to advertise being physically active as cool, fun and a	1 year. For the baseline survey, persons in 60.5% of sampled households completed the screening interview. Among eligible adult respondents, 3084 (87.0%) completed the parent interview; 3120 eligible child respondents (81.3%) completed the child interview. As determined with standard American Association of Public Opinion Research response rate formulas, the overall baseline	The overall campaign produced high levels of awareness. 26% of the participants had no recall of the VERB campaign, 7% had recall but no understanding, 50% had aided recall with understanding and 17% of the participants had unaided recall with understanding. Therefore, the overall awareness (all three categories that had recall) achieved by the VERB campaign was 74% among the nation's 9- to 13-year-old youths. Ninety percent of children who were aware of VERB also demonstrated understanding of the messages. Overall awareness for White children and Hispanic/Latino children was 78% and 70%, respectively, significantly higher than that for Black children at 63% ($p > 0.05$). A significant positive relationship was detected between the level of awareness of VERB and weekly median sessions of free-time PA among the total population of 9- to 13-year-old youths ($p <0 .05$), meaning that, as VERB awareness increased, levels of PA increased. Within subgroups, this relationship between increasing levels of awareness and more free-time	Self-report. Reverse causation is a possibility – physically active children becoming more aware of the campaign. Overall awareness for White children and Hispanic/Latino children was 78% and 70%, respectively, significantly higher than that for Black children at 63% ($p > 0.05$).

					chance to have good time with friends. Paid advertising ran nationally from June 2002 to June 2003 targeting youths 9–13 years. A baseline survey was conducted between April and June 2002, before the campaign started, (random digit dialling method). Same cohort of parent–child dyads followed-up after 1 year. **Providers of intervention:** Research staff, advertising agencies, the National Centre for Chronic Disease Prevention and Health promotion and Centres for Disease Control and Prevention in Atlanta.	response rate was 43% (the product of the completion rates for the screening, parent, and child interviews). At the follow-up assessment in 2003, data were collected from 2732 of the same dyads (87.6%).	sessions of PA was also observed at the $p > 0.05$ level for 9- to 10-year-old children, White children, children whose parents had less than a high school education, children from households with incomes of US$25,000 or less, and incomes between $50,000 and $75,000, children living in urban areas of high density, children from rural areas, children who reported engaging in less than three free-time PA sessions at baseline and children who reported engaging in at least three free-time sessions at baseline. The average 9–10-year-old engaged in 34% more free-time PA sessions per week than did 9–10 years olds who were unaware of the campaign. When free-time PA sessions of all US children were compared with those of the children who were unaware of the campaign no overall effect on free-time PA sessions was detected at the population level. However, within subgroups, significant overall effects were observed for 9–10 year old children, girls, children with parental education of less than high school, children from households with income US$25,001 to $50,000, children living in urban areas of high density, and children who were low	

							active at baseline ($p > 0.05$). At the total population level no relationship was found between awareness of VERB and organized activity ($p > 0.05$). Within the subgroup classified as low active at baseline, 39.1% of children were engaged in an organised PA, compared with 31.9% of the comparison group, a significant difference of 7.2 percentage points ($p > 0.05$). The other subgroup effect for organised activity was for children with parents with a college degree or higher education level.	
Tudor-Smith et al. 1998	Before and after design but samples are independent (cross-sectional) population surveys with an intervention community and a matched reference area.	2	–	**Geographical area:** Wales, UK and north-east England (reference area). Wales: 1985: n = 18538 1990 n = 13045 North-east England: 1985 n = 1483 1990 n = 4534 All participants were aged between 18–64 years No further details.	To assess the 5-year effect of an intervention of a community-based demonstration project called 'Heartbeat Wales'. See weight outcomes table (Table 1) for more detail.	Cross-sectional survey took place before and after the end of the 5-year intervention in intervention and control community. See weight outcomes table (Table 1) for more detail.	Engage in moderate or strenuous activity at least two times per week for over 20 min each time: Wales 2.1 (95% CI 0.8–3.4), control 3.2 (95% CI –0.7–7.1) percentage point changes.	The sample size at the baseline measurement at baseline in the North East was too small to give sufficient statistical power to detect a net intervention effect. There is evidence of increases in funding for heart health promotion in the reference area and diffusion of other health promotion campaigns (contamination).

EVIDENCE TABLE 4: CORROBORATIVE EVIDENCE (WEIGHT, DIET AND ACTIVITY)

Evidence of corroboration (external validity)								
Evidence of salience – Is it appropriate for the UK?								
First author	**Study design**	**Research type**	**Research quality**	**Study population**	**Research question and design**	**Length of follow-up**	**Main results**	**Confounders/comments**
Hillsdon et al. 2001	Before and after study.	2	+	English adults (NB: non-completers were younger; fewer were in social grade AB, owned their own home or car. Fewer had children or perceived that PA would lead to physiological benefits. More were non-White. Compare with non-completers).	See above.	See above.	See above.	See above.
Tudor Smith 1998	Before and after study.	2	–	Wales	See above.	See above.	See above.	See above.
Miles 2001; Wardle 2001	Before and after study.	2	+	British adults (NB: evaluation participants were more likely to be from higher SES, less likely to be smokers, less likely to be classified as vigorous exercisers and more likely to be classified as obese compare with British population).	See above.	See above.	See above.	See above.
Wimbush 1998	Before and after study.	2	–	Scotland	See above.	See above.	See above.	See above.

Jeffery 2005	Survey of Earlybird cohort.	N/A		UK parents and their children.	Explored parent's awareness of overweight in themselves and their children.	N/A	19% of children, 52% of mothers and 72% of fathers were overweight (including obese). Among overweight parents, 40% of mothers and 45% of fathers judged their own weight 'about right' and 27% of mothers and 61% of fathers were unconcerned about their weight. Only one-quarter of parents recognised overweight in their child. Parents were less likely to identify overweight in sons than in daughters. More mothers than fathers correctly assessed their child's weight. Maternal weight status did not affect mothers awareness of children's weight but only 74% overweight fathers compared with 85% normal weight fathers were correct. 86% of parents who were unaware their child was overweight were also unconcerned. Prevalence of overweight in parents did not differ by SES, neither was there a difference in correct perception of child's weight between SES groups.	

Hastings et al. 2003	Systematic review	N/A		Literature search 1970–2003. Studies used for this particular research	Does food promotion influence children's nutritional knowledge? Five studies were RCTs	No details provided.	The eight studies provide modest evidence of an effect on children's nutritional knowledge. Four studies found that exposure to food promotion had a significant impact	Four of the studies did not take a baseline measure of knowledge and therefore it is very

				question covered an age range of 3–16 years and all but one of the studies was conducted with North American samples in the 1970s and 1980s.	and three were cross-sectional surveys. The control condition in one of the experiments (Ross et al, 1980, 1981) comprised exposure to non-food adverts; in the other four studies the control condition involved no exposure to any adverts. The food promoted in the adverts of the experimental studies were adverts for cereals and soft drinks (Ross et al. 1980, 1981), branded sugar snacks and breakfast cereals (Goldberg et al. 1978a, 1978b), sugared foods (Goldberg et al. 1978a,1978b; Galst 1980) measured whether the effect of a pro-nutritional television programme' was modified by being shown alongside advertisements.		on or was associated with differences in nutritional knowledge. Three studies found that exposure to food promotion had no impact on or was not associated with changes in children's perceptions of the healthiness of different foods or what constitutes a healthy diet.	difficult to ascertain whether experimental and control groups differed in nutritional knowledge before the experiment.
Hastings et al. 2003	Systematic review	N/A		Literature search 1970–2003. Participants were all	Does food promotion influence children's food preference?	No details provided.	Fourteen studies provide reasonably strong evidence of food promotion on children's preferences.	One study (Ritchey & Olson 1983) did not describe the TV viewing measure

				North American and ranged in age from 2 to 18 years. The majority of the studies were conducted in the 1980s.	Fourteen studies were used, with 13 of them being experiments and one being a cross-sectional study (Ritchey & Olson 1983). Twelve of the studies used a similar study design, which involved exposing one or more experimental groups to one or more food promotion stimuli, and 11 of them compared children's subsequent food preferences or attitudes to those of a control group exposed to a different or no stimuli. The food promotion stimuli in the experimental studies were all advertisements for various products (branded sugared snacks, breakfast cereals, non-specific 'sugared foods', salty snacks, sweets, soft drinks, ice cream and 'pronutrition foods'. Six studies measured if different modifications to the experimental stimuli		Of the four higher scoring studies, three found that promotion had significant effects on children's product and brand preferences. Three of these studies (Goldberg et al. 1978a, 1978b; Stoneman & Brody, 1981; Kaufman & Sandman 1983) found that children were more likely to choose high fat, salt or sugar foods than alternative 'healthy' products after viewing food advertisements. Of the five medium scoring experimental studies, three found that food promotion had effects on children's products and brand preferences (Gorn & Goldberg 1980a; Heslop & Ryans 1980; Borzekowski & Robinson 2001). Borzeowski & Robinson (2001) found that children were more likely to choose the advertised brand than a non-advertised brand of the same product type after exposure to food advertisements. Gorn & Goldberg (1980a) found that food promotion had an effect on children's brand and to a lesser extent product preferences. Of the two lower scoring experimental studies, Clarke (1984) found no significant effects ($p > 0.05$) while Norton et al. (2000) found that television advertising was reported to be a significant influence only on degree of liking for three products	used so it was not possible for the author to judge what level of potential exposure was measured. There were inconsistencies in parental and child reporting of child food preferences within the study, and the authors themselves suggested that the preferences measure used was possibly not sensitive enough to detect difference between children. All the studies used for answering the research question were graded for quality. Four studies were high scoring in terms of quality, five experimental studies were medium scoring and two of the studies were lower scoring.

					weakened or strengthened children's effect on food preferences. Five of the studies asked children to pick between products in different categories (lower fat, sugar or salt vs. higher fat, sugar or salt). Five studies also asked children to choose between different brands of the same product, one or more of which had been advertised on the experimental tape and one or more of which had not. Two of the studies (Gorn & Goldberg, 1980; Gorn & Florsheim 1985) measured product preferences but between alternatives that were necessarily designated healthier and less healthy.		which are generally not excessively advertised on television: chicken, apples, beans and low-fat milk. Two studies did not report results.	
Hastings et al 2003	Systematic review	N/A		Literature search 1970–2003. The participants in the studies were 475 9–12-year-old English speaking	Does food promotion influence children's food purchasing and purchase related behaviour?	No data provided.	All seven studies reviewed found that exposure to food promotion had an influence on, or was significantly associated with the specific purchase related behaviour measured in each study. The findings were reported according to the type of behaviour	The two cross-sectional studies would have been stronger had they used multiple regression analysis to examine the

				and French speaking children in Montreal (Goldberg 1990), 36 3–5-year-old children in Georgia and their mothers (Stoneman & Brody 1982), 775 4th–7th grade children in Michigan (Atkin 1975b), 66 mothers of children aged 3–8 years in Californian public 'preschools' and elementary schools (Taras et al. 1989), 41 3–11-year-old children (mean age range 4–7 years) in New York and their mothers (Galst & White 1976), 100 children aged 3–13 years in Michigan (Reeves & Atkin 1979) and vending machine users in 12 secondary schools and 12 workplaces in Minnesota (French et al. 2001). The samples achieved a reasonably			measured in each study. **Sales:** Sales of low-fat snacks increased significantly and proportionately with increasing price reductions and promotional labels and signage also had a small, independent effect on low fat-snack sales. Promotion (labelling and signage) was significantly and independently associated with increased low-fat snack sales ($p > 0.04$). Overall sales volume was unrelated to promotion, but was related to price reduction. **Observed purchase influence behaviour:** No significant difference was found between experimental group and control group children in numbers of hours of television reportedly viewed per week, and the two groups of children did not differ in the amount of attention they paid to the experimental tape, which increased the likelihood of the observed differences in behaviour being attributable to the experimental tape. A study by Galst & White (1976) who focused on children's supermarket behaviour after being exposed to food advertising found the more effort a child exerted to keep the overall videotape playing and the more effort they exerted to watch advertisements the more 'purchase influence attempts'	relationship between food promotion and other factors on purchase related behaviour.

				representative range of income levels.			they made per minute in the supermarket. **Household purchase:** A study by Goldberg (1990) which examined the degree to which children are affected by television advertising found that children who had the highest level of US TV viewing reported more household purchase of children's cereals (mean 2.67) than children with a low level of US TV viewing (mean 1.62). There was also a significant effect for income ($p > 0.01$), with low-income children reporting more household purchase of children's cereals (mean 2.42) than upper-middle income children (mean 2.03). No significant effects were found for language nor were any significant interactions found, although the interaction of level of US TV viewing by income approached significance ($p > 0.007$). **Reported purchase influence behaviour:** A study by Atkin (1975b) who measured exposure using a 'cereal advertising exposure index' found that children who reported watching more Saturday morning television more often asked for cereals. More than twice as many 'heavy viewers' of Saturday morning television as 'light viewers' reported making cereal purchase	

							requests ‘a lot’ of the time. A study by Taras et al. (1989), which investigated the relationship between children’s television viewing and their food purchase requests, found significant correlations were found between hours of TV viewing and the number of food items which mothers perceived had been requested because of television’s influence ($p = 0.006$) and the number of food items subsequently purchased ($p = 0.01$). Snacking while watching television was also significantly positively correlated with number of food items requested and purchased and with energy intake.	
Hastings et al. 2003	Systematic review	N/A		Literature search 1970–2003. Participants in all the 11 studies were all North American and the age range was 2–11 years. Some involved relatively small sample sizes (e.g. Cantor 1981, $n = 37$), while other studies involved samples of several hundred, such as Atkin (1975b) $n = 775$ and Bolton (1983) $n = 262$.	Does food promotion influence children’s food consumption behaviour? Eleven studies investigated the effects of exposure to food promotion on children’s food consumption behaviour (defined as encompassing three types of behaviour: one - off consumption, short-term consumption and self-reported regular patterns of consumption behaviour.	No details provided.	Two experimental studies (Gorn & Goldberg 1980b, 1982) found that exposure to food promotion had an effect on children’s consumption. It reduced likelihood of selecting fruit or orange juice, compare with a sweet for a daily snack. Three cross-sectional studies (Atkin 1975b; Bolton 1983; Ritchey & Olson 1983) found small but significant associations between exposure to television food advertising and frequency of snacking or consumption of foods ($p > 0.05$). Two studies (Jeffrey et al. 1982; Dawson et al. 1988) found variations in consumption behaviour, according to exposure to food promotion, but the results were not statistically significant	

				Several studies involved using participants who were mainly middle class (Galst 1980; Gorn & Goldberg 1980a; Bolton 1983; Dawson et al. 1988).	Eight of the studies were RCTs and three were cross-sectional studies.		($p > 0.05$) and no effect could be concluded. Four studies produced results, which were inconclusive. Galst (1980) appeared to indicate that exposure to food promotion had a positive effect on consumption behaviour (i.e. it reduced children's selection of sugared snacks), whereas Peterson et al. (1984) found that exposure to food promotion had no effect on children's consumption behaviour, but it was not possible in wither study to disentangle the effects of food promotion from other experimental stimuli examined at the same time. Cantor (1981) and Gorn & Goldberg (1980a) reported that exposure to food promotion had an effect on consumption behaviour but that under certain conditions it did not. Cantor (1981) reported the effect was to increase consumption of sweet foods while in Gorn & Goldberg (1980a) the effect was to reduce consumption of ice-cream. Overall, the studies used provide evidence of an effect of food promotion on consumption behaviour. Effects were sometimes inconsistent and were not found in all the studies, but were found in sufficient studies to suggest that food promotion influence children's food consumption.	

Hastings et al 2003	Systematic review	N/A		Literature search 1970–2003. The age range of the participants was 2–20 years. Five of the studies were North American and one was Australian. Dietz & Gortmaker (1985) had a very large sample of nearly 11,500 and Wong et al. (1992), Gracey et al. (1996) and Bolton (1983) also had large sample sizes of 1081, 391 and 262 respectively. Bolton's (1983) sample was predominantly White and of higher SES, whereas in Coon et al. (2001), the sample was non-randomly selected and of above average educational level; the other samples appeared to reflect a range of SES groups.	Does food promotion influence children's diet and health-related variables? Six cross-sectional studies were used to investigate the research question, four of which investigated the relationship between television and children's diet. The other studies examined health related variables and one examining the relationship between TV viewing and obesity.	No details provided.	There were small but significant (*p* > 0.05) associations between TV viewing and diet, television and obesity and television viewing and cholesterol. In five of the studies, the possible effect of food advertising on this relationship could not be distinguished from the general effect of the TV viewing. One study by Bolton (1983) which attempted to measure the specific contribution of food advertising found that the greater a child's food advertising exposure, the more frequent a child's snacking and the lower his or her nutrient efficiency.	Coon et al. (2001) and Gracey et al. (1996) studies had a number of limitations. Gracey et al. (1996) study used a long questionnaire administered under school staff supervision, but with only a one-item question on TV viewing. The validity of this could well be questionable compare with other diary recall types of question. Also the generalisability of the findings to all Australian children maybe questioned. In the Coon et al. (2001) study the way TV viewing was measured was poor and the sample appears to have been unrepresentative of the general population in the study's geographical area.
Hastings et al.	Systematic review	N/A		School children.	If food promotion is shown to have an effect	No details provided.	Seven cross-sectional studies and one experimental study (French 2001).	

2003					on children's food knowledge preferences and behaviour what is the extent of this influence relative to other factors?		There is evidence from studies of various methodological quality that food promotion or TV viewing significantly influences children's food behaviour and diet independently of other factors known to influence children's food behaviour and diet. However there is little evidence to show whether the influence of food promotion on children's food behaviour and diet is greater or lesser than that of other factors. One study found that 25–50% price changes appeared to have a stronger influence than promotional signage on low-fat snack sales from vending machines in secondary school. However, promotion significantly increased low-fat snack sales independently of pricing strategies (French 2001). Another study showed that food advertising exposure had a small but significant and independent impact on diet but explained less of the variance in snacking frequency than parents snacking frequency (Bolton 1983).	
Conclusion: Food promotion can have and is having an effect on children, particularly in the areas of food preferences, purchase behaviour and consumption. Most studies uncover an effect that will be harmful however there is evidence that promotion can have a beneficial effect. Food promotion has the potential to influence children in a positive way. There is evidence that food promotion has an effect on children's nutritional knowledge. The evidence presented supports the ideal that food promotion may have little influence on children's general perceptions of what constitutes a healthy diet, but that it can have an effect on more specific types of nutrition. There is good evidence that food promotion has an effect on children's food preferences. In particular there is strong evidence that food promotion influences children's food purchase-related								

behaviour. In the majority of studies the effect was in the direction of increasing purchase requests for foods high in fat, sugar or salt.

There were also significant effects between TV viewing and diet, and between TV viewing and health related variables; food promotion or TV viewing significantly influences children's food behaviour and diet independently of other factors known to influence children's food behaviour and diet. Although there is minimal evidence demonstrating the influence of, food promotion on children's food behaviour and diet is greater or lesser than that of other factors.

First author	**Study design**	**Research type**	**Research quality**	**Study population**	**Research question and design**	**Length of follow-up**	**Main results**	**Confounders/ comments**
Family Food Survey 2003 Prepared by the www.raisingkids.co.uk (Dr P Spungin).	Survey	N/A		Parents and within the UK (all areas). The survey was open to parents with children under the age of 18 years living in the UK. *n* = 1521 parents 29.7% of respondents were one-child families. 44.0% were two-child families. 16.3% were three-child families 10% were four-child families.	A large-scale survey was undertaken on the 'raisingkids.co.uk' website to investigate the influence of food advertising alongside numerous other factors, including knowledge of nutrition and parenting values. The survey and paper covered three main topics: • food knowledge; • food purchasing; • attitudes to advertising to children.	N/a	85% of survey respondents were correct in thinking that children should only be given semi skimmed milk when they are >2 years of age. 56% of respondents knew that beef was the best source of iron from a particular selection of foods. Only 13% of respondents knew that that an 8-year-old boy should consume 1750 kcal (7.3 MJ)/day. When asked about the main source of information about their children's diet and	

				Amongst the sample, in total the families had 2547 children (1718 boys and 1829 girls).			nutrition, 43% said that their main source was from books and magazines and 15% relied on family and friends. Out of 1521 parents, only 13 (0.9%) said their main source of information was the Food Standards Agency. **Food purchasing:** 98% of respondents deemed nutritional value 'important' or 'very important'. Parents may not have flawless food knowledge, but is still a big issue when selecting food. 'What children prefer' and 'value for money' were next in the rankings with 91% and 86% of people surveyed rating them 'important' or 'very important' respectively. Regionally and socio-economically, there was very little difference in opinions, although 'price' is rated less important by the higher earners.	

							63% stated that advertising was the biggest influence if a child asks for a new product. Other influences included' linked to a TV programme' and 'on the box promotion' receiving 37% and 36% respectively. The peer group is also a significant influence, with 50% of mothers saying 'They've seen it at school or friends have said it's good'. 14% of mothers let their children try a product after being asked to buy the product that a child has seen advertised. The survey reports that most parents make a decision depending on the food values of the product or the price. **Attitudes to advertising to children:** Of the people surveyed only 190 (12.9%) stated that they would like	

							advertising for children to be banned. 45% of respondents agreed with the statement 'I accept advertising is a commercial reality'. Although parents have certain reservations about advertising and the effects it has on children, they accept it. Parents recognise that in educating children to realistic expectations, with by far the largest response (96%) being 'It's up to parents to explain they can't have everything they see advertised'.	
Goode 1996	Survey and in-depth interviews	N/A		420 adults living in Leicester and Leicestershire, 58% female, 53% employed full-time, 95% White.	Examined how respondents made dietary choices.	N/A	High levels of awareness of healthy eating initiatives (72% aware of dietary recommendations aimed at improving the health of the nation), of nutritional knowledge, and of accuracy when asked to apply such knowledge. Despite knowledge there were those who failed to make dietary changes.	

							64% reported having made dietary changes due to increased awareness of healthy eating messages.	
Maddock 1999	Interview-administered survey and group discussions.	N/A		311 people representative of UK in terms of age, socio-economic class, employment status and region.	To investigate the nations current degree of interest in healthy eating and to find out whether people are taking note of guidelines.		High level of awareness of need to reduce sugar/salt and fat intake, some confusion regarding types of fat and their health effects and very few knew recommended intake is five portions of fruit and vegetables per day. No statistically significant difference in involvement in healthy eating according to demographic variables; within the groups respondents indicated that excessive information on healthy eating could have the opposite effect to the one intended.	
McCullough 2004	Questionnaire as part of a case study.	N/A		171 primary school children and 124 parents in one primary school in Manchester UK compares with	To compare awareness towards nutrition education between primary schools in UK and Korea and nutritional knowledge.	N/A	Children and parents are aware of importance of limiting fat, sodium and sugar intakes and requiring non-starch polysaccharide. In the case of some foods they	Data not extracted for Korean children and their parents.

				school in Korea (10–11 years old).			did not have satisfactory knowledge of which foods were high in salt, fat, sugar and non-starch polysaccharide. British **children** had less knowledge of salt levels in cornflakes, ketchup and chips and did not realise that chocolate and cake are high-fat foods. Children identified parents as main source of nutritional information. Children perceived health/nutrition as most important factor in choosing food followed by taste and parental influence (however their preferences suggested taste is most important). 16% British children selected fruit as their favourite snack yet 33% said they would buy fruit if they had an extra £2 for food. British children preferred to learn about nutrition through cookery classes then information packs then computer packages.	

							British **parents** said taste was most important factor for choosing food then health/nutrition, appearance and price. Least important factor was TV and friends. British parents said main source of information on nutrition was from doctor/health professional. 32% British parents said extra £10 per week available for food would be spent on fruit.	

Evidence for implementation – will it work in the UK?

First author	Study design	Research type	Research quality	Study population	Research question and design	Length of follow-up	Main results	Confounders/comments
Hillsdon et al. 2001	Before and after study.	2	+	See above.	See above.	See above.	**Providers of intervention:** Commissioned by Department of Health and run by Health Education Authority.	See above.
Miles 2001; Wardle 2001	Before and after study.	2	+	See above.	See above.	See above.	**Providers of intervention:** The Health Behaviour Unit, Department Epidemiology and Public Health from University College, London and the BBC Education department. Omnibus National Survey used to evaluate.	See above.
Wimbush et al. 1998	Before and after	2	+	See above.	See above.	See above.	**Providers of intervention:** Health Education board for Scotland.	See above.

	study.						Staff from the Centre for Leisure Research at Heriott Watt University, Edinburgh Staff from the Centre for Social Marketing at Strathclyde University, Glasgow.	
Tudor-Smith et al. 1998	Before and after study.	2	–	See above.	See above.	See above.	**Providers of intervention:** Health Promotion Wales and research staff.	See above.

SEARCH STRATEGIES

1. *obesity/pc
2. *weight gain/
3. *weight loss/
4. *body image/
5. *body mass index/
6. *skinfold thickness/
7. waist: hip ratio.tw.
8. overweight.ti.
9. weight control.ti,ab.
10. obes$.ti,ab.
11. weight maintenance.ti,ab.
12. (weight gain or weight loss).ti,ab.
13. exp mass media/ or telecommunications/ or advertising/ or marketing/
14. *internet/
15. (increas$ adj3 awareness).ti,ab.
16. (rais$ adj3 awareness).ti,ab.
17. (assess$ adj3 awareness).ti,ab.
18. (promot$ adj3 awareness).ti,ab.
19. (public adj1 awareness).ti,ab.
20. *awareness/
21. *health promotion/
22. *health education/
23. broadcast media/
24. (television adj campaign).ti,ab.
25. (radio adj campaign).ti,ab.
26. (publicity adj campaign).ti,ab.
27. (health adj campaigns).ti,ab.
28. *health behavior/
29. or/1-12
30. or/13-28
31. 29 and 30
32. limit 31 to (humans and yr="1990 - 2005")

The following seven website addresses were searched using the keywords “obesity”, “raising awareness”, “advertising”, “media” and “marketing”:

Clinical Evidence - http://www.clinicalevidence.org
EPPI-Centre - http://eppi.ioe.ac.uk/
Food Standards Agency - http://www.food.gov.uk/science/research/
Health Evidence Bulletins – Wales - http://hebw.cf.ac.uk
IUHPE (International Union for Health Promotion and Education) - http://www.iuhpe.nyu.edu/pubs/index.html
NCCHTA - http://www.ncchta.org
NICE – www.nice.org.uk

Public Health Effectiveness (Hamilton, Ontario) - http://www.health.hamilton went.on.ca/CSCARB/EPHPP/ephpp.htm and SIGN – http://www.sign.ac.uk, were also searched for relevant data.

DATA SOURCES

The following information sources were searched:

ABI/INFORM
ASSIA
British Nursing Index
CENTRAL (Cochrane Controlled Trials Register)
Clinical Evidence - http://www.clinicalevidence.org
Cochrane Database of Systematic Reviews
CRD (EED database) http://www.york.ac.uk/inst/crd
DARE
Embase
Emerald
EPPI-Centre - http://eppi.ioe.ac.uk/
ERIC
Food Standards Agency - http://www.food.gov.uk/science/research/
Health Evidence Bulletins – Wales - http://hebw.cf.ac.uk
IUHPE (International Union for Health Promotion and Education) - http://www.iuhpe.nyu.edu/pubs/index.html
Medline
NCCHTA - http://www.ncchta.org
NICE – www.nice.org.uk
Public Health Effectiveness (Hamilton, Ontario) - http://www.health.hamilton-went.on.ca/CSCARB/EPHPP/ephpp.htm
PsycINFO
SIGN – http://www.sign.ac.uk
Social Science Citation Index (equiv. to Current Contents)
Sociological Abstracts

The electronic search strategies were developed in Medline and adapted for use with the other information sources. The Cochrane database was double checked for relevant RCTs – as the agreed review parameters. Bibliographies of included studies were searched, as were key reports and systematic reviews within these topic areas.

EXCLUDED REFERENCES

Paper	Reason for exclusion
A leaner fitter future. Options for Action 2003. Association for the Study of Obesity, MRC Human Nutrition Research, London School of Hygiene and Tropical Medicine.	Multi-sector perspective on overweight in children to stimulate engagement and action within UK – all relevant references collected.
Abbott R. Food and nutrition information: a study of sources, uses, and understanding. *British Food Journal* 1997;99(2):43–9	Self-selecting survey of Boots plc employees in UK re nutritional understanding and awareness – excluded from corroborative evidence as self-selecting employees of Boots plc, may not be generalisable to general British population.
Ashwell M. The media and slimming. *Proceedings of the Nutrition Society* 1991; 50(2):479–92.	Review of how media uses scientific information on obesity.
Bessell TL, McDonald S, Silagy CA, Anderson JN, Hiller JE, Sansom LN. Do Internet interventions for consumers cause more harm than good? A systematic review. *Health Expectations* 2002;5(1):28–37.	Systematic review of Internet vs. non-internet interventions, not aimed at raising awareness.
Bogue J. Determinants of consumers dietary behaviour for health-enhancing foods. *British Food Journal* 2005;107(1):4–16.	Dublin, consumer questionnaire to determine awareness of health benefits of health enhancing foods and dietary behaviour – excluded from corroborative evidence as based in Ireland, may not be generalisable to English mainland.
Booth M, Bauman A, Oldenburg B, Owen *N*, Magnus P. Effects of a national mass-media Campaign on physical activity participation. *Health Promotion International* 1992;7:241–7.	One-month mass media campaign to promote awareness of health benefits of PA in Australia. Not controlled, before and after using independent representative sampling.
Borra ST, Kelly L, Shirreffs MB, Neville K, Geiger CJ. Developing health messages: qualitative studies with children, parents, and teachers help identify communications opportunities for healthful lifestyles and the prevention of obesity. *Journal of the American Dietetic Association* 2003;103(6):721–8.	US-based consumer research to inform future education campaigns to help prevent obesity.
Brown JD, Witherspoon EM. The mass media and American adolescents' health. *Journal of Adolescent Health* 2002; 31(6 Suppl):153–70.	Review of mass media on US adolescents health; obesity only mentioned in context of TV as sedentary behaviour and media images of thinness linked to eating disorders, nothing regarding raising awareness of healthy weight/diet/exercise.

Bull FC, Holt CL, Kreuter MW, Clark EM, Scharff D. Understanding the effects of printed health education materials: Which features lead to which outcomes? *Journal of Health Communication* 2001;6:265–79.	1 month RCT of three different types of printed health education materials in obese Australian adults. Mainly attitudes, beliefs, awareness, some self-report of trying suggestions in booklets.
Caroli M, Argentieri L, Cardone M, Masi A. Role of television in childhood obesity prevention. *International Journal of Obesity and Related Metabolic Disorders* 2004; 28(Suppl 3):S104–8.	Non-systematic review of negative consequences of TV food advertising on food choice and consumption in children.
Cheung L. Do media influence childhood obesity? *Annals of the New York Academy of Sciences* 1993;699:104–6.	Short review of media influence.
Eagle L, Bulmer S, De Bruin A, Kitchen P. Exploring the link between obesity and advertising in New Zealand. *Journal of Marketing Communication* 2004;10:49–67.	Non-systematic review of negative influences of food advertising on children.
Finlay S-J, Faulkner G.Physical activity promotion through the mass media: Inception, production, transmission and consumption. *Preventive Medicine* 2005;40:121–30.	Systematic review of PA promotion through the mass media, includes UK studies. Reviewers excluded this review in preference for systematic review by Cavill et al. 2004. All UK studies included in both reviews. Finlay updates a previous review but substantive focus is on analysis from critical media studies perspective.
Goodman RM, Wheeler FC, Lee PR. Evaluation of the heart to heart project - lessons from a community-based chronic disease prevention project. *American Journal of Health Promotion* 1995;9:443–55.	Mass media plus community intervention – Heart to Heart project – non-UK. To reduce cardiovascular risk factors, pre–post design using matched comparison areas, 5 years.
Goran. Interactive multimedia for promoting PA (IMPACT) in children. *Obesity Research* 2005;13:762–71.	Evaluates efficacy of use of multimedia in schools to promote PA, 8-week CBA.
Halford JC, Gillespie J, Brown V, Pontin EE, Dovey T, Jason CG. Effect of television advertisements for foods on food consumption in children. *Appetite* 2004;42:221–5.	Two-week CBA assessing food consumption in children in Liverpool immediately after exposure to food adverts, obese children appeared to have heightened alertness to food cues.
Harvey-Berino J, Pintauro S, Buzzell P, Gold EC. Effect of internet support on the long-term maintenance of weight loss. *Obesity Research*	RCT with internet support for weight maintenance in one of three arms following

2004;12(2):320–29.	weight loss treatment.
Holmes LaWTM. HeartWell – healthy alliances in action. *Nutrition and Food Science* 1996;(6):25-28.	HeartWell community-based project in Scunthorpe, UK, various projects but media/public health was only one element in community-based projects, no outcomes reported. Excluded from corroborative evidence as no usable outcomes.
Hopper D, Barker ME. Dietary advice, nutritional knowledge and attitudes towards nutrition in primary health care. *Journal of Human Nutrition and Dietetics* 1995; 8:279–86.	Study of dietary advice given by members of Sheffield PHCT and their nutritional knowledge and attitudes towards nutrition – excluded from corroborative evidence as focuses on nutritional advice given by general practitioners (GPs) and practice nurses (more relevant to primary care).
Jansson S. Food and Health: experience from Sweden. *Health Education Journal* 1993;52:253–5.	Review of interviews with Swedish adults on food and health.
Jason LA, Greiner BJ, Naylor K, Johnson SP, Van Egeren L. A large-scale, short-term, media-based weight loss program. *American Journal of Health Promotion* 1991;5:432–7.	Media recruitment obese US adults to RCT with 3-month follow-up to assess media diet and exercise programme vs. media plus self-help group.
Jason LA. Tobacco, drug, and HIV preventive media interventions. *American Journal of Community Psychology* 1998; 26(2):151–87. Ref ID: 1111	Non-systematic review of media interventions.
Jordan Lin C-T, Lee J-Y, Yen ST. Do dietary intakes affect search for nutrient information on food labels? *Social Science and Medicine* 2004;59:1955–67.	Not an intervention; uses survey data to explore dietary intake and self-reported search for food label information in US adults.
Kline SE, Kline MA. Countering children's sedentary lifestyles: An evaluative study of a media-risk education approach. *Childhood* 2005;12(2):239–58.	Not an intervention; non-systematic review of media and sedentary lifestyles.
Kreuter MW. Understanding how people process health information: A comparison of tailored and nontailored weight-loss materials. *Health Psychology* 1999;18(5):487–94.	One-month RCT of tailored vs. non-tailored health education materials for weight loss in obese adult US women – same study as Kreuter 2000.
Kreuter MW. Are tailored health education materials always more effective than non-tailored materials? *Health Education Research* 2000;15(3):305–15.	One-month RCT of tailored vs. non-tailored health education materials for weight loss in obese adult US women.
Lambert N. Dibsdall LA, Frewer LJ. Poor diet	Review that compares anti-smoking

and smoking: the big killers: comparing health education in two hazard domains. *British Food Journal* 2002;104(1): 63–75.	campaign with UK five-a-day campaign, gives useful refs for five-a-day campaign but exclude this particular review – relevant references obtained.
Matson-Koffman. A site-specific literature review of policy and environmental interventions that promote PA and nutrition for cardiovascular health: what works? *American Journal of Health Promotion* 2005;19:167–93.	Review of environmental and policy interventions to increase PA and improve nutrition; included in Broader Community Review (Cardiff).
Meyers AW, Graves TJ, Whelan JP, Barclay DR. An evaluation of a television-delivered behavioral weight loss program: are the ratings acceptable? *Journal of Consulting and Clinical Psychology* 1996;64(1):172–78.	Evaluates efficacy of television delivery of weight loss in obese adults; RCT with 15 month follow-up, obese at baseline.
Miles J, Petrie C, Steel M. Slimming on the Internet. *Journal of the Royal Society of Medicine* 2000; 93(5):254–7.	Assess website content of weight loss diets compare with clinical guidelines.
Molnar AE, Molnar MA. School commercialism hurts all children, ethnic minority group children most of all. *Journal of Negro Education* 2004;72(4):371–8.	Review of school commercialism in USA.
Norman SA, Greenberg R, Marconi K, Novelli W, Felix M, Schechter C et al. A process evaluation of a two-year community cardiovascular risk reduction program: what was done and who knew about it? *Health Education Research* 1990;5(1):87–97.	To increase awareness of cardiovascular disease risk reduction (i.e. smoking and hypertension as well as weight), cross-sectional survey one-year apart, only measures awareness, US study.
Palmer S, Graham G, Elliott E. Effects of a web-based health program on fifth grade children's physical activity. Knowledge, attitudes and behavior. *American Journal of Health Education* 2005;36:86–93.	US crossover study of internet HealthyHeart4Kids in school to increase PA knowledge and behaviours. Only 8–9 weeks duration and doubts over validity of study design.
Philipp R. Public awareness of healthy life-style factors and sources of advice. *Health Education Journal* 1988;47:26–8.	Survey of public awareness of healthy life-style factors – published 1988.
Reid D. How effective is health education via mass communications? *Health Education Journal* 1996;55:332–44. Ref ID: 2514	Non-systematic review of mass media and health education
Rodgers AB**,** Kessler LG, Portnoy B et al. 'Eat for Health': a supermarket intervention for nutrition and cancer risk reduction. *American Journal of Public Health* 1994;84:72–6.	Twenty US supermarkets were matched paired with another 20 supermarkets, campaign for healthy eating ran for 2 years

	with three cross-sectional surveys.
Roefs A, Jansen AE, Roefs MA. The effect of information about fat content on food consumption in overweight/obese and lean people. *Appetite* 2004;43:319-322.	Two taster sessions to assess effect of labelling on food consumption in lean and obese adults in Netherlands.
Sanders TA, Woolfe R, Rantzen E. Controlled evaluation of slimming diets: use of television for recruitment. *Lancet* 1990; 336(8720):918–20.	UK – 6-week RCT of seven commercial slimming diets and placebo, BBC programme 'That's Life' helped carry out trial and presented on TV in 1987.
Seiders K & Petty RD. Obesity and the role of food marketing: A policy analysis of issues and remedies. *Journal of Public Policy Marketing* 2004;23:153–69.	US-based non-systematic review of food marketing.
Singh BM, Prescott JJ, Guy R, Walford S, Murphy M, Wise PH. Effect of advertising on awareness of symptoms of diabetes among the general public: the British Diabetic Association Study.*British Medical Journal* 1994; 308(6929):632–6.	Raising awareness through advertising of diabetes symptoms. Pre–post test, not controlled. Baseline, after 10 weeks advertising, then 10 weeks after advertising withdrawn. UK-based but only on awareness of diabetic symptoms.
Soweid Rema A Afifi. Changes in health-related attitude and self-reported behavior of undergraduate students at the American University of Beirut following a health awareness course. *Education and Health* 2003;16:265–78. Ref ID: 1892	Health awareness course within a University. Pre–post design, not controlled. One semester. Move in stages of change for fruit and vegetable intake and exercise for 16 students. American University of Beirut, Lebanon.
Strasburger VCE, Victor C, V. Children and TV advertising: Nowhere to run, nowhere to hide. *Journal of Development and Behavioral Pediatrics* 2001;22(3):185-187.	Commentary on relationship between food advertising, unhealthy eating practice and obesity in children.
Taylor CB, Fortmann SP, Flora J, Kayman S, Barrett DC, Jatulis D et al. Effect of long-term community health education on body mass index. The Stanford Five-City Project. *American Journal of Epidemiology* 1991; 134(3):235–49.	Mass media plus community intervention (non-UK) – Stanford Five City. To reduce cardiovascular risk factors Cohort and cross-sectional data with treatment and control cities 6-year.
Variyam JN, Callahan R. Diet-health knowledge, awareness of federal nutrition information programs, and obesity. *FASEB Journal* 2004;18:A846.	Uses survey data to assess link between awareness of federal nutrition information programs and overweight in US adults, abstract only.
Wantland DJ, Portillo CJ, Holzemer WL, Slaughter R, McGhee EM. The effectiveness of web-based vs. non-web-based interventions: A	Systematic review of web-based vs. non web-based interventions for behaviour change – order two references which may

meta-analysis of behavioral change outcomes. *Journal of Medical Internet Research* 2004;6(4):e40.	be relevant – this review is excluded as other included studies not relevant.
Woodward DR, Cumming FT, Ball PJ, Williams HM, Hornsby H, Boom JA. Does television affect teenagers' food choices? *Journal of Human Nutrition and Dietetics* 1997;10:229–35.	Cross-sectional survey in Australia of children TV and food choice.
Zaccari V. Walking to school in inner Sydney. *Health Promotion Journal of Australia* 2003;14:137–40.	Pre–post not controlled. Project in Australian schools to increase awareness of benefits of walking to school but only 4 weeks.