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Food etc

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1. EXERCISE AND APPETITE

1.1. EXERCISE IMPACTS APPETITE

Exercise is a good way to reduce weight via energy expenditure, but "it may also generate a compensatory increase of energy intake (EI) induced by additional energy demand, which may partially account for the less than desired effect of exercise on weight reduction" (Hu et al 2023 p1) [1]. Appetite is a mediator of EI [2].

The previous research is inconsistent on exercise and subjective appetite (table 1.1). "An important factor to explain the inconsistency is the differences in exercise intensity. Physiological responses to high intensity exercise (VO2max>70% [3]), such as blood redistribution, insulin concentration, and muscle metabolism that potentially influence appetite hormone signals..., could be different from the responses to lower intensity exercise, which may explain the greater suppression of hunger and stimulation of fullness (ie: "exercise-induced anorexia"; King et al 1994) observed in higher intensity exercise" (Hu et al 2023 p1).

Hu et al (2023) investigated the intensity of exercise and appetite in their meta-analysis. The main difference is between high-intensity interval training (HIIT) (short bursts of maximum effort interspersed with recovery periods) and moderate-intensity continuous training (MICT). A literature search was made for peer-reviewed studies in English, published up to 1st

[1] Zhou et al (2023) stated: "Exercise (defined here as structured, planned activity requiring physical effort and coordination) has ostensibly paradoxical effects in both elevating motivation to eat and enhancing satiety..., but in the longer-term aligns energy intake with sustained increases in energy expenditure" (p1).

[2] Blundell and Beaulieu (2023) defined appetite as "the totality of processes that influence food consumption, and which therefore includes sensations of hunger, fullness and a desire to eat, eating patterns, food selection, food hedonics and satiety" (p1).

[3] V = volume, O = oxygen, max = maximum. It refers to the maximum rate of oxygen consumption by the body. >70% = 70% or more of that maximum.

- In 2003 a consensus meeting of experts concluded that moderate intensity physical activity 45-60 minutes per day prevents overweight and obesity, while 60-90 minutes is required for overweight and obese individuals to lose weight (Blundell and Beaulieu 2023).

- In terms of evidence, an overview of twelve systematic reviews (including 149 studies) (Bellicha et al 2021) concluded absolutely that exercise reduces body mass and fat. "However, the reductions are quite modest (although this is partly a function of the limited time periods of the training and low doses of exercise employed), ranging from 1.5 to 3.5 kg body mass loss and 1.3–2.6 kg fat loss over a period of 2 weeks–12 months" (Blundell and Beaulieu 2023 p2).

- This may be due to increased EI after exercise. Prolonged frequent exercise is important because any increased EI will be offset by greater energy expended. It has been noted that "exercises increases the sensitivity of the appetite control system, reducing the susceptibility to overconsumption" (Blundell and Beaulieu 2023 p3).

Table 1.1 - Exercise and appetite.

September 2021, which included randomisation of participants, adult samples, HIIT and/or MICT, and outcome measures of subjective appetite. Thirteen studies were included.

Compared to no-exercise control groups, exercise suppressed appetite immediately post-exercise, but there was no difference 30-90 minutes post-exercise. Comparing HIIT and MICT, there was no difference in appetite immediately after exercise, but there was greater hunger perception 30-90 minutes post-MICT.

There were a number of methodological issues with the studies in the meta-analysis, including:

i) The measurement and conception of subjective appetite - eg: hunger perception; fullness; desire to eat (generally or specific foods).

ii) The length and type of HIIT (eg: 30-240 second intervals at 85-100% VO2max) and MICT (eg: 20-60 minutes) (eg: cycling; treadmill running).

iii) All studies used a cross-over (or repeated) design, which meant that participants performed all conditions, but the time between the different conditions varied.

iv) The majority of participants were male.

v) Five studies recruited overweight adults and eight studies normal weight range individuals.

vi) Provision of and type of food before exercise, and time between eating and exercise.

vii) Control of potential confounders - eg: gender; body composition (ie: fat mass percentage); fitness level; individual food preferences.

Studies usually focus on averages. Blundell and Beaulieu (2023) added the role of individual differences into a complex situation and made this statement: "Our view is that prolonged periods of exercise training (or habitual daily physical activity) in general sensitise the appetite system so that there is better response to imposed energy perturbations. However, the physiological demands of exercise can simultaneously adjust distinct components of the system (fasting hunger, post-prandial satiety, response to energy density of foods, hedonic response) which will not be identical in every person. The patterns of appetite responses leading to adjustments in daily EI, when set against the cumulative energy expended in prolonged exercise, generate differences in energy balance which lead to differences in body composition (especially fat stores) over time" (p4).

What influences EI after exercise? Hochsmann et al (2023) investigated a selection of factors in an analysis of data from the EAT-FC (Exercise, Appetite and Temporal Food Choices) study in the USA. Fifty-seven adults volunteers in the normal weight range performed a 45-minute exercise bout and a 45-minute rest condition on different occasions. Biological measures included peak oxygen uptake, and heart rate, while the behavioural measures included eating behaviour traits (eg: uncontrolled eating; emotional eating). Post-exercise EI thirty minutes after exercise was the outcome measure when participants could eat as much as they wanted (in an ad libitum meal).

Female habitual exercisers ate less, while males with higher baseline blood concentrations of peptide Y (PPY) (an appetite-suppressing hormone [4]) consumed more food post-exercise. This latter finding was unexpected, and the researchers could not explain it. Eating

[4] Hormones related to appetite can be divided into orexigenic (appetite stimulating) hormones (eg: ghrelin), and anorexigenic (appetite suppressing) hormones (Grigg et al 2023).

behaviour traits were not significantly predictive of post-exercise EI.

Resistance exercise (RE) and appetite has not been fully explored, particularly the different variables like training load, training volume, and inter-exercise rest (Liu et al 2023).

Liu et al (2023) undertook an experiment with eleven healthy young men in Taiwan. Participants performed in three conditions - moderate-level RE (four sets of exercises and eight repetitions at 85% maximum weight), low-level RE (45% maximum), and a resting control. Subjective hunger was reported as lower on a 100 mm visual analogue scale (VAS) immediately after exercise in the two RE conditions compared to the control condition. There was also decreased ghrelin and increased peptide YY. There was no difference between the two RE conditions.

Purcell et al (2023) studied one hour of resistance training (eg: leg press; dumbbell bicep curls) (and no exercise) by sixteen breast cancer survivors in the USA, followed ninety minutes later by an ad libitum buffet-style lunch. There was no significant difference in EI or subjective appetite between the two conditions.

The strengths of this study was the focus on breast cancer survivors, though the sample size was small. The researchers approached 265 women via a Breast Centre in Colorado between May 2020 and January 2022, ninety-two responded, but 21 started the study with sixteen completing both conditions. The inclusion and exclusion criteria were very strict. Other strengths of the study included standardised pre-exercise meal and exercise sessions. But diet prior to study days was not controlled. The sample was mostly White, "relatively lean pre-menopausal" women (Purcell et al 2023 p8).

1.2. FREQUENCY OF PHYSICAL ACTIVITY

Prolonged sitting can be interrupted by short frequent bursts of physical activity or by long infrequent periods of it. What is the impact of these two strategies on subjective appetite?

Maylor et al (2023) performed an experiment with fourteen sedentary females to answer this question. The participants were volunteers at an English university who reported sitting for seven hours or more each day. All participants undertook all conditions with a week's break in between them. The three conditions, each lasting 7.5

hours, were: (i) uninterrupted sitting at a desk (Sit), (ii) two-minute walks every thirty minutes (Short Breaks), and (iii) ten-minute walks every three hours (Long Breaks). Meals were provided after fifteen minutes, three hours, and six hours. Subjective appetite was measured on a 100 mm VAS in response to the question, "How hungry do you feel?".

There was no change in subjective appetite or actual food consumed in the two physical activity conditions compared to the Sit condition. So, the study suggested that "breaking up sitting with short frequent or longer duration less frequent physical activity breaks do not cause a compensatory change in appetite, appetite hormones or subsequent energy intake in females with variable weight status" (Maylor et al 2023 p6).

The study had two important methodological strengths:

i) The randomised crossover design meant that all participants performed in all conditions, which allowed the comparison of "like with like", but the order was randomised among the participants.

ii) Taking place in a laboratory environment for 7.5 hours during which regular measurements were taken, while food intake, and physical activity were controlled by the researchers.

This study confirmed findings with both males and females in the normal weight range (eg: Bailey et al 2016).

1.3. TIME OF DAY

Does exercise in the morning or evening differ for post-exercise EI and appetite? Mode et al (2023) investigated this question with sixteen healthy young adults at a university in England. Over two test days, participants completed the same fifteen-minute intensive cycling exercise programme at 10.30 am (AMEx) or 6.30 pm (PMEx). The amount eaten at the post-exercise ad libitum meal was the main outcome measure, along with regular ratings of subjective hunger.

EI was significantly greater after PMEx than AMEx (mean 835 vs 683 kcals), but there was no difference in post-exercise subjective hunger ratings.

These findings contradicted O'Donoghue et al (2010), who found no differences in EI after 45 minutes of

treadmill running at 7 am or 5 pm by healthy young males. But running "causes greater gastro-intestinal discomfort than cycling" (Mode et al 2023 p6), which may influence eating before and after the exercise. In a longer study with overweight or obese participants, Creasy et al (2022) found a slightly reduced EI after evening exercise and an increase after morning exercise. Mode et al (2023) offered the suggestion that "lean individuals and individuals living with overweight or obesity exhibit different eating behaviours in response to morning and evening exercise. It is also possible that changes in energy intake occurs at eating occasions other than the meal immediately following exercise..." (p6), though they did not think the latter was the case.

Key evaluation points of Mode et al's (2023) study include:

i) Small sample, but 50% male and female. They were "weight stable (self-reported >6 months), not currently dieting, not taking any medication, and were recreationally active (completing more than 1 h but less than 10 h structured exercise per week). Participants were not restrained, disinhibited, or hungry eaters..." (Mode et al 2023 p2).

ii) The order of the two conditions was counterbalanced in this repeated measures design experiment with four days between the two conditions.

iii) The 24 hours of the test days were controlled with a standardised meal the night before, breakfast, lunch, and dinner (depending on the exercise condition and ad libitum meal). Eating and exercise were self-reported for non-study days. EI after leaving the laboratory was not controlled beyond asking participants to refrain from further eating for two hours.

iv) Baseline and regular measures (objective and subjective) using standardised means were taken.

v) There were two control or baseline days.

Beaulieu et al (2023) investigated timing of exercise and appetite with the extra variable of individual chronotype. "An individual's chronotype reflects preferences in the timing of sleep, physical activity and eating, typically defined as morning, neither/intermediate, and evening chronotypes" (Beaulieu

et al 2023 p1).

In terms of previous research, Beaulieu et al (2020), in a study of young British adults, found that "a later chronotype was associated with a greater BMI, weaker suppression of appetite and greater wanting but not liking for high-fat food" (Beaulieu et al 2023 p1).

Beaulieu et al (2023) performed their experiment in Saudi Arabia with forty-five young men. The participants completed the "Morningness-Eveningness Questionnaire" (MEQ) (Horne and Ostberg 1976) to establish their chronotype. Two bouts of thirty minutes of intensive cycling were undertaken on two different days - one between 8-10 am and the other between 5-7 pm.

Twelve participants were classed as "morning types", eleven as "evening types", and the remainder as "intermediate". Lower hunger was reported after exercise that fitted with the chronotype - ie: morning types after the morning exercise compared to afternoon exercise, and evening types with the later compared to the earlier exercise.

Few of the participants were "true" morning or evening chronotypes (Beaulieu et al 2023).

1.4. TYPE OF EXERCISE

The type of exercise is important. "Anecdotal evidence suggests that water-based exercise influences appetite differently to land-based exercise, with participants commenting that they felt 'ravenous' after swimming... Empirical evidence suggests that exercising in cold water may increase appetite, making it a less favourable mode of exercise to promote body mass loss and facilitate weight loss maintenance" (Grigg et al 2023 p2). Studies, however, can be variable, as seen in Grigg et al's (2023) review and meta-analysis. Nine relevant studies were found that covered water-based exercise versus land-based exercise, water-based exercise versus no exercise, and/or water-based exercise at different water temperatures, and EI and appetite.

The following conclusions were drawn:

a) Post-exercise EI is higher after water-based exercise compared to no-exercise controls (an average of 330 kJ).

b) There was no difference in EI after water- or land-based exercise.

c) Water-based exercise in colder water led to higher EI subsequently. An average difference of 719 kJ between 18-20 °C and 27-33 °C water temperature.

The researchers added that "whilst a meta-analysis was not possible due to a paucity of data, it is posited that hunger is suppressed during and immediately after water-based exercise, but participants were hungrier in the subsequent hours when compared to control or a land-based comparator based on the available empirical literature" (Grigg et al 2023 p9).

The nine studies varied in a number of ways, including:

i) The type and length of water- or land-based exercise - eg: swimming; aqua-cycling; treadmill walking or running; 45-90% of VO_2max (ie: moderate to high intensity).

ii) The length of the study - eg: a single bout of exercise vs 12 weeks of training.

iii) The sample - eg: only males or females.

iv) The measurement of EI, appetite, and hunger - eg: ad libitum meal 15 minutes or one hour post-exercise.

v) The type of design - eg: independent or cross-over.

1.5. PHYSIOLOGICAL CHANGES

A circulating protein called "Growth Differentiation Factor 15" (GDF15) has been studied in animals, and shown to reduce food intake, preference for energy-dense food, and body weight. "Somewhat contradictory to these effects, observational studies in humans have reported elevated concentrations of GDF15 in individuals with obesity and type 2 diabetes... and positive associations between GDF15 and diabetes incidence" (Quist et al 2023 p2). Meanwhile plasma GDF15 concentrations have been found to increase after vigorous exercise by healthy humans, suggesting that GDF15 is "a part of the complex exercise-related control of appetite" (Quist et al 2023 p2).

Quist et al (2023) provided data from the "Governing Obesity - Action Commuting To Improve health and Well-

being of Everyday life" (GO-ACTIWE) study in Denmark. One hundred and thirty physically inactive overweight or obese 20-45 year-olds were recruited. They were allocated to active commuting by bike, moderate or vigorous leisure-time exercise, or no exercise for six months. Multiple measures were taken on test days.

Plasma GDF15 increased after exercise, but did not change with fitness levels. It was not associated with appetite or energy intake. Higher GDF15 was associated with poorer health in non-exercise individuals (ie: "a less favourable cardio-metabolic profile"; Quist et al 2023 p1).

1.6. APPLICATIONS

"Though logical, increasing energy expenditure with regular bouts of acute exercise to induce an energy deficit does not consistently translate to weight loss" (Moniz et al 2023 p1). This is particularly so for women as exercise-induced weight loss can vary over the menstrual cycle (specifically related to changes in oestradiol and progesterone levels). Moniz et al (2023) showed this in a study of twelve women in Canada.

The participants performed vigorous-intensity running-based exercise on a day during the follicular phase (FP) (approximately eight days after the onset of menses) and the luteal phase (LP) (approximately 22 days). EI on the day of exercise in the LP was significantly greater than in the FP.

Table 1.2 lists the key strengths and weaknesses of the study.

STRENGTHS	WEAKNESSES
1. Detailed history of menstrual cycle taken, and the exclusion of women who had been pregnant in the last three years. 2. The use of ovulation kits to determine of LP. 3. Matched conditions in terms of exercise, and pre-exercise food intake.	1. No control condition (ie: no exercise during the LP and FP). 2. Small sample of active women. 3. Though the researchers attempted to control EI in the 24 hours before exercise days, it was dependent on the compliance of the participants.

Table 1.2 - Key strengths and weaknesses of Moniz et al (2023).

In terms of the application of research to individuals with obesity, Fillon et al (2023) compared dietary restriction and physical exercise among twenty obese 12-16 year-olds in France. In both conditions, an energy deficit of 400 kcal was created over a day before allowing the participants to eat as much as they wanted for dinner. There was also a control condition.

Food intake was greater in the dietary restriction condition (mean 1112 kcal) than the exercise condition (mean 1009 kcal) and the control condition (mean 983 kcals), as was subjective appetite before dinner (means 11.5, 8.3 and 9.6 respectively). This suggested that exercise produced an appetite suppression which could aid weight loss.

Recovering after exercise is about restoring glycogen and water stores. What is ingested in this process could be important, particularly in weight management programmes. "Consumption of bovine (cow's) milk after exercise is one nutritional strategy that might satisfy the competing goals of optimising post-exercise recovery, whilst simultaneously suppressing appetite/energy intake" (Corney et al 2023 p2).

Rumbold et al (2015), for example, found that "ingestion of skimmed milk following 30 min sub-maximal exercise in a group of recreationally active females reduced energy intake 60 min later, compared to an energy-matched fruit juice beverage" (Corney et al 2023 p2). But this study did not have a control group, which Corney et al (2023) rectified in their study with ten healthy males. In the three conditions, each separated by 7-14 days, after thirty minutes of moderate exercise, participants consumed skimmed milk, an energy-matched sucrose beverage, or a low-energy placebo. Subjective appetite was measured as well as consumption of a pasta meal one-hour post-exercise.

EI was significantly less after the milk drink than the other two (mean 6746 kJ vs 7762 for sucrose beverage and 7672 with placebo). There was no difference in the pre- and post-meal subjective hunger scores.

The researchers speculated that the physiological mechanisms behind the findings: "Milk contains high quality protein, that can stimulate post-exercise muscle protein synthesis..., as well as possibly suppressing appetite. At rest, protein-containing beverages have been shown to increase satiety and/or decrease subsequent energy intake... These effects of protein are believed to be caused by effects on appetite-regulatory hormones" (Corney et al 2023 p5).

The study only measured EI one hour after exercise.

Corney et al (2023) ended thus: "we conclude that in situations where weight management (weight reduction or maintenance) is an important consideration, but that rapid intake of nutrients post-exercise might benefit short-term recovery or long-term adaptation, consumption of skimmed milk post-exercise may offer a practical and cost-effective strategy to achieve these goals" (p6).

Almesbehi et al (2023) undertook a review of studies on exercise and appetite hormones among adults with overweight or obesity. Nine relevant studies were found (eg: randomised controlled trials; at least four weeks of exercise programme). Overall, there was no impact of exercise on the hormones, though there was a decrease in body weight.

The studies varied in terms of methodology, including:

i) Sample - eg: only male or female, or both; overweight and/or obese; mean age range 28-69 years; mean BMI 27 - 32 kg/m^2; size from 26 to 186 participants.

ii) Duration, frequency, and intensity of exercise programme (eg: endurance training; 45-60 minute sessions; 8-52 weeks in length; 50-70% VO_2max).

iii) Outcome measure - ie: the hormone(s) measured, and method used to do so.

iv) Randomisation of participants to exercise or control - five studies provided full details of this process.

v) Blinding to condition difficult for both participants and researchers.

vi) Drop-out - as high as one-third in one study.

Blundell and Beaulieu (2023) stated this conclusion: "The issue of obesity is not a question of diet OR inactivity. It is both" (p4).

1.7. CONCLUSIONS

Single bout or acute exercise has been studied as well as structural, habitual or chronic physical exercise/activity. Thackray and Stensel (2023) commented

on the former and experimental studies: "A central finding to emerge from this work is the consensus that acute moderate- to high-intensity exercise (typically ≥60% of peak oxygen uptake) transiently suppress feelings of appetite assessed using subjective visual analogue scales... The loss of appetite during and immediately after exercise has been described as 'exercise-induced anorexia'... and often coincides with commensurate fluctuations in gut-derived peptides that influence hunger and satiety on a meal-by-meal basis" (p2).

There appears to be no EI compensation, at least in the short term. "Although the absence of compensatory increases in energy intake in response to exercise energy expenditure cannot persist indefinitely if stored energy and body composition are challenged, it is difficult to determine when and to what extent any compensatory adaptations in the appetite control system may emerge with repeated exposure to exercise. An inherent challenge for all human nutrition investigations is the inability to quantify food intake accurately and objectively in free living environments. Most free living studies rely on self-reported dietary intake that has been shown to systematically under-estimate energy intake by hundreds of calories a day" (Thackray and Stensel 2023 p2).

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2. REGULATING EATING

2.1. TIME-RESTRICTED EATING

Time-restricted eating (TRE) (or time-restricted feeding (TRF) in animals) is a form of "intermittent fasting" which "entails restricting eating within a window of 4 to 12 hours per 24-hour cycle and prolonging the time spent in the fasted state to realign eating-fasting patterns with circadian rhythms" (Papageorgiou et al 2023 p86).

Randomised controlled trials (RCTs) have shown benefits of TRE in relation to obesity, diabetes, and cardiovascular diseases (Papageorgiou et al 2023) (table 2.1). It seems that "although individuals following TRE are commonly not provided guidance on caloric intake, several studies have reported inadvertent reductions in caloric intake (due to eating during a shorter time window and/or reduced consumption of energy-dense foods commonly consumed in the evening), which have been reported to contribute to weight loss and the associated metabolic benefits" (Papageorgiou et al 2023 p86).

- Human clinical trials in TRE started in 2013, and increased subsequently. "Published studies have varied greatly in the duration and timing of fasting, duration of intervention, participant population, assessment of eating window, and outcomes" (Manoogian et al 2022b p429).

- For example, Manoogian et al (2022b) noted that 30 of 39 studies used an 8-10-hour daily eating window, and thirty-one of the studies lasted between 4-12 weeks. The most common participants were overweight or obese adults (18 of 39 studies), and the most common finding was a decrease in body weight (twenty-four studies).

Table 2.1 - Human RCTs in TRE.

But there may be adverse effects on bone health (eg: total bone mineral content (BMC) or bone mineral density (BMD)) from TRE. Short RCTs of six and twelve weeks did not find so (eg: Martens et al 2020), but because "a

minimum monitoring time interval of 6 months is recommended for repeating bone mass measurements, it is possible that small changes were not captured in these shorter-term studies" (Papageorgiou et al 2023 p86).

Papageorgiou et al (2023) analysed data from a six-month Swiss study of TRE and metabolic health (Phillips et al 2021). Forty-two volunteers were randomly allocated to the TRE group (eating whatever they wanted during a 12-hour time window of their choice), or the standard dietary advice (SDA) control group (who received brief advice on a healthy diet). There was no difference in bone health between the two groups after six months.

Interestingly, the participants in the control group changed their eating behaviour, and some lost weight. This showed the importance of the nature of a control group, and it cannot be assumed that they will not change their behaviour during the study period.

Papageorgiou et al's (2023) study had the strength of the RCT design, and standardised methods of assessing bone health. But the sample was relatively small, with three-quarters being female. The researchers also accepted that "the lack of detailed information regarding changes in lifestyle factors (ie: caloric intake and macro-nutrient distribution, intake of dietary calcium and vitamin D, and exercise characteristics, including frequency and mode [resistance/aerobic exercise]) that may affect bone parameters is a limitation of this work" (Papageorgiou et al 2023 p93).

Firefighters work long and erratic shifts, which can have negative health consequences, and lifestyle interventions to improve health are hard to implement. TRE may offer an option, and Manoogian et al (2022a) performed a randomised clinical trial over twelve weeks of 10-hour TRE (the "Healthy Heroes" study). The sample was 137 individuals on 24-hour shifts with the San Diego Fire-Rescue Department in California [5].

At baseline around three-quarters of the sample had at least one cardio-metabolic risk factor (eg: BMI ≥30; high blood pressure; elevated cholesterol levels). All participants were advised to follow a "Mediterranean diet", and then either within a 10-hour window in every 24 hours (TRE group) or to eat whenever they wanted (control group).

TRE proved to be an acceptable dietary intervention with no adverse effects, and improved quality of life scores. The TRE group showed health benefits compared to baseline on a number of measures (eg: body weight).

[5] Less than 10% of the sample was female.

2.1.1. Circadian Rhythms

TRF was found in early studies with rodents to link to circadian rhythms (ie: food intake was the "most powerful cue" to these rhythms) (Manoogian et al 2022b).

Subsequently, TRF to 8-12 hours was found to reduce calorie intake and prevent obesity in rodents given unlimited access (ad libitum) access to food (Manoogian et al 2022b).

Rodent studies have shown that TRF has an effect on the liver, adipose tissue, and gut function (eg: increases the relative amounts of obesity-protective gut micro-flora). These are benefits related to metabolic health, like insulin resistance and diabetes. Eating earlier in the day in TRE in humans seems best here (eg: Sutton et al 2018). "Yet, many barriers exist to implementing early eating window restriction in humans, notably the social and societal influences that encourage late eating..." (Manoogian et al 2022b p413).

In the development of a TRE regimen, there are two key considerations (Manoogian et al 2022b):

a) Duration - eg: 4-6, 8-10, or 9-12 hours per 24-hour period. "There is not yet a consensus on the duration of a daily eating window that is needed to achieve the benefits of TRE" (Manoogian et al 2022b p415).

b) Phase - eg: early. The melatonin cycle is known to influence food consumption, and high levels (as late at night) can inhibit the glucose response to food. Thus, "to avoid eating when melatonin levels are high, choose an eating window that does not start for at least an hour after waking and at least 3 hours before sleep onset" (Manoogian et al 2022b p415).

2.2. CALORIE LOADING

The idea that a "calorie is a calorie" in weight management is being challenged by studies "suggesting that the time of day when a large meal is consumed may influence weight loss effectiveness [6]. These studies imply that calories ingested at different times of the day have different effects on energy utilisation, leading to

[6] Protein from food may behave differently in the body depending on its source. A cell-based study (Chen et al 2022) found that 2% less protein passed across the gut wall from plant-based meat alternatives than from chicken (Wong 2022).

differential weight loss..." (Ruddick-Collins et al 2022 p1472).

This has been tested by comparing "morning-loaded" (ML) and "evening-loaded" (EL) diets (ie: eating the majority of the daily calories at that time). For example, among ninety-three overweight and obese women on a twelve-week diet, the ML group lost an additional 5 kg (Jakubowicz et al 2013) (table 2.2). It is proposed that "calorie utilisation varies across the day, with calories consumed in the morning being less efficiently utilised than calories consumed in the evening, resulting in greater energy expenditure (EE) relative to intake and thus enabling more effective weight loss" (Ruddick-Collins et al 2022 p1472). This idea is supported by work on rodents and the circadian rhythms. For instance, animals fed the same high-fat diet at the "wrong" time (ie: when the animal would be sleeping normally) become obese compared to eaten at the "correct" time (eg: Arble et al 2009).

- Calorie intake - 50% breakfast/36% lunch/14% dinner (ML group) vs 14%/36%/50% respectively (EL group).
- Non-compliance was defined as deviation of 10% or more from recommended 1400 cal/day. Drop-out was 17% (n = 8) in ML group and 23% (n = 11) in EL group. Failed to keep to 1400 cals/day was main reason for drop-out.
- Average weight loss after 12 weeks - 8.7 kg (or 10% in BMI) (ML group) vs 3.6 kg (5% of BMI) (EL group).
- Large meal example - whole-wheat bread (2 slices), light tuna in water, skim milk (16 fl oz), milk chocolate (1 bar), salad, grande Americano.
- Small meal example - 2 scrambled egg whites, large Americano, turkey breast (5 slices).

Table 2.2 - Key details of Jakubowicz et al (2013) study.

Ruddick-Collins et al (2022) compared ML and EL diets over four weeks with thirty overweight and obese volunteers. The ML diet was 45% of total daily calorie intake at breakfast, 35% at lunch, and 20% at dinner, while the EL diet was 20/35/45% respectively. There was also a baseline diet where the calories were equally divided between the three meals. The participants had all food and beverages provided by the experimenters. Any leftovers were weighed, and any extra food was recorded.

All participants had one week of baseline diet, then fourteen participants were randomised to ML first and sixteen to EL first for four weeks. Then followed one week of baseline diet again, and four weeks of the opposite diet. This was a randomised crossover design.

There was no significant difference in weight loss between ML and EL diets (average 3 kg weight loss or 3-4% of body weight after four weeks). But the "ML diet resulted in significantly lower average daily hunger, desire to eat, prospective consumption, thirst, and composite appetite score (calculated as (hunger + desire to eat + food quantity... compared to the EL diet (Ruddick-Collins et al 2022 pp1475-1476).

There are a number of limitations with the study that might explain the lack of difference between the ML and EL diets, including:

i) It was a "free-living" study (ie: individuals lived their normal lives and reported to the researchers regularly for measurements). Ruddick-Collins et al (2022) admitted: "While the benefit of this is the replication of real-living context (ie: living in a lab would largely impact participants' normal physical activity), this increases the chances of participant non-compliance. However, given the regularity of attendance at the nutrition unit, provision of all meals, and regular body weight checks, we believe any non-compliance not reported in food records was minimal and did not largely influence the study outcomes" (p1481).

ii) The distribution of calories between the three meals. Many participants could not eat the required amount (eg: 45% of total daily calorie intake at one meal). Leftovers were significantly higher at breakfast. Also some foods were rejected for enjoyment reasons, despite a pre-study screening of foods.

iii) The period between the two diets was one week (known as the "wash-out period"), and "this may not have been long enough to reduce the influence of the previous diet period on the next assessment period. A within-subject cross-over design was necessary to assess subjective changes in appetite but has a higher participant burden due to the length of time on a controlled diet" (Ruddick-Collins et al 2022 p1481). the strength of this type of design is that all participants perform all conditions, which allows comparison of the same individuals with ML and EL diets. Jakubowicz et al (2013) used an independent parallel design where

participants performed in one condition only, and both conditions occurred at the same time.

iv) Some of the measures, like EE, were calculated by mathematical modelling. If the participants had been in a controlled environment, then actual EE could have been measured continuously (or almost continuously).

v) The participants were able to choose their meal times. There was "a modestly longer eating window across the day in the ML compared to EL diet" (Ruddick-Collins et al 2022 p1475).

vi) The participants were volunteers who responded to local media advertisement at a Scottish university. The mean age was 51 years old, with sixteen males and fourteen females. The average body mass index (BMI) was 32.5 kg/m^2 [7] with no health problems. The sample size was smaller than Jakubowicz et al (2013).

vii) The study lasted ten weeks in total, with four weeks on one particular diet. This is shorter than Jakubowicz et al's (2013) study, which lasted twelve weeks on the diet. Other studies have lasted longer (eg: 20 weeks; Garaulet et al 2013). Ruddick-Collins et al (2022) observed: "Notably, although statistically significant differences in weight loss were evident by week 4 in the study by Jakubowicz, in the Garaulet study, late eaters only began to display a slower rate of weight loss starting after the 5th week of treatment. It is therefore possible that we may have found more striking effects in terms of weight loss over a longer duration" (p1475).

2.3. PORTION SIZE

Robinson et al (2023) stated the problem: "Large portion sizes of commercially available food products have been identified as a likely contributor to the rise in overweight and obesity across the developed world. Food portion sizes have increased over time, and the current food environment is characterised by a wide availability of energy-dense food products sold in larger portion sizes" (p888). One meta-analysis (Zlatevska et al 2014), for example, of increased portion sizes calculated that a doubling of size produced an energy intake increase of one-third (Robinson et al 2023). Simply,

[7] A BMI of 30.0 kg/m^2 and above is classed as overweight or obese.

increased energy intake without increased energy expenditure produces weight gain.

So, would reducing portion size ultimately lead to weight loss (or, at least, not weight gain)? It is not clear "whether consumers 'compensate' for reduced portion sizes by eating more at later meals and whether reductions in portion size meaningfully affect daily energy intake and body weight" (Robinson et al 2023 p888). In terms of compensation, a laboratory study by Haynes et al (2020), for instance, found that a smaller main course portion size given to participants led to them choosing a larger dessert.

In relation to total daily energy intake, the studies are divided over whether this is reduced by smaller portion sizes. This led Robinson et al (2023) to perform a meta-analysis of experiments that manipulated portion size across at least one day, and measured energy intake. Fourteen eligible studies were found (table 2.3).

- Experiments with at least two conditions - a smaller portion and a larger or standard size.
- Not participants with health conditions or undergoing treatment that might influence appetite (eg: bariatric surgery).
- Manipulation of food portion size using same food type for all participants.
- Energy intake measured by objective means or self-reports, or a combination of both.
- Manipulation of one meal or more per day.

Table 2.3 - Key eligibility criteria used by Robinson et al (2023).

Overall, manipulated smaller portions led to lower daily energy intake, and for both men and women. "Reductions to daily energy intake were larger in studies that manipulated the portion size of foods at most meals as opposed to studies that only manipulated portion size at one or two meals" (Robinson et al 2023 p900). It was calculated that a 50% reduction in portion sizes would be associated with a decrease in daily energy intake of 8%. Put another way, a 100 kcal reduction in energy content of portion sizes would be associated with a 14 kcal decrease in daily energy intake. In terms of compensation, the researchers found some evidence, "but this compensation was only partial and this compensation

does not become larger over time" (Robinson et al 2023 p901). Reductions in portion size over the long term, and across the population would reduce weight (or limit weight gain).

As with any meta-analysis, the studies included varied in methodological aspects. Here are a number of key methodological differences and issues:

i) Experimental design - Within-participant/repeated design (where participants had smaller and larger portions at different times) (thirteen studies) or between-participant/independent design (where participants were randomised to one condition only) (one study).

ii) Length of study - eg: number of days that energy intake measured (six studies = one day vs six studies = a single meal), and follow-up (six months in one study).

iii) Magnitude of portion size reduction - eg: 50% (varied from 14 kcal in a single meal to 1865 kcal with multiple meals). But also whether the reduction was "large" to "standard" or "standard" to "small". There was a curvilinear relationship where "reductions to daily energy intake were markedly smaller (approximately 33%) when reducing portion size from a large portions to a 'normal'/intermediate portion, compared with reducing portion size from a 'normal'/intermediate portion" (Robinson et al 2023 p900).

iv) Outcome measure - eg: objective only (nine studies). It was found that "studies that relied in part on participant self-reports of food consumed to calculate energy intake reported smaller effects of portion size on daily energy intake than studies relying on researcher-measured energy intake. Given that participant self-reported energy intake is prone to recall bias and inaccuracy, participant reporting biases may under-estimate the effect of portion size on energy intake in some studies" (Robinson et al 2023 p901).

v) Controls - eg: participants required to consume meal in full; in laboratory or real-world setting; type of food. Robinson et al (2023) noted that Gough et al (2021) found that "the effect of portion size on short-term energy intake was larger when tested in the real world vs laboratory, therefore we presume that the reliance on laboratory-based studies in the present meta-analysis would be more likely to under- rather than over-

estimate the effect of portion size" (p902).

vi) Location of study - Nine studies in the USA, four in the UK, and one in Singapore.

vii) Samples - University recruited mostly (ie: students and staff); both men and women or only one gender; adults (except two studies included children); number of participants ranged from 19 to 172.

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3. UNIVERSAL PREVENTION OF EATING DISORDERS

3.1. INTRODUCTION

Jones et al (2017) began with this observation: "There is understandable consensus about the need to prevent the development of eating disorders and associated risk factors and to build positive body image and eating behaviours... Yet, there is less consensus about how this should be achieved or at what point in symptom development it is most effective to intervene" (p1) [8].

One possibility is large-scale intervention, very early in the development of symptoms (known as "universal prevention"; UP). Gordon (1983) defined UP as a "measure that is desirable for everybody... which can be advocated confidently for the general public" (quoted in Jones et al 2017). Other definitions include "the notion that participants in universal prevention have not been identified on the basis of their individual risk" (Jones et al 2017 p1).

Foxcroft (2014) outlined three functions of prevention programmes - environmental, developmental, and informational. "Briefly, universal programmes with an environmental purpose are designed to reduce the opportunities to engage in unhealthy behaviours. Universal programmes with a developmental function are designed to promote psycho-social maturation in ways that increase resistance to unhealthy influences. The third functional category consists of universal programmes that provide information in order to improve awareness, knowledge, and attitudes about unhealthy beliefs and behaviours" (Levine 2017 p6).

[8] Austin et al (2017) commented that "[W]ell over 100 preventive interventions for eating disorders and disordered weight and shape control behaviours have been evaluated and published in the scientific literature in recent decades... and a number of successes with preventive effects have been documented" (p9).

Interventions can be universal (an entire population), selective (high risk individuals), and targeted (individuals showing early symptoms) (Becker et al 2017). Whether universal or targeted programmes, Breithaupt et al (2017a) noted two problems with the latter: "Targeted prevention programmes require a trained individual to identify at-risk individuals, increasing both prevention costs and professional time, which are often unavailable resources at schools... Second, identifying individuals in schools may stigmatise these already at-risk individuals... For example, targeted in-school depression prevention programmes increase perceived stigma in comparison to universal programmes" (p33). Concerning UP programmes, they are "easier to maintain and do not stigmatise individuals, but less likely to motivate and empower adolescents to make the behavioural and cognitive changes necessary to reduce their risk of developing an eating disorder" (Breithaupt et al 2017a p33).

Bell et al (2017) advocated "zooming out" from individual or micro-level factors to macro-level issues in UP programmes (ie: "a model of universal prevention that targets whole populations, with a focus on inclusiveness and diversity, but more importantly, often focuses on broader environmental factors, including individual-level, cultural, economic, and political interventions"; p89). "Zooming out" also includes new methodologies (eg: the use of social media), and new stakeholders (eg: advertisers).

That is not to say that programmes aimed at the individual level should be ignored. Such UP "includes interventions targeted at the individual level, received by an entire population, delivered in such a way that renders them acceptable, integrated into, and even hopefully, owned by the community. Such universal prevention efforts may provide entire communities (including peers, parents, teachers, and health care providers) with the tools to resist the onslaught of negative socio-cultural messages surrounding the importance of appearance and the malleability of body shape that are conveyed by the media and the broader social discourse. They may also reduce the potential for stigmatisation among high-risk individuals who can be singled out by targeted interventions" (Bell et al 2017 p89).

Foxcroft (2014) commented: "...whilst the universal-selective-indicated system for classifying prevention is a useful advance on previous notions of primary and

secondary prevention, there remains some conceptual confusion about how environmental, community-based and individually oriented prevention approaches should be classified and how these different types of prevention relate to the universal-selective-indicated scheme" (quoted in Levine 2017). Levine (2017) described nine features of UP (table 3.1).

- Not selective.
- Addresses large groups.
- Focuses on common risk and protective factors in the general population.
- The population includes non-symptomatic individuals.
- UP involves public institutions and policies.
- Includes media campaigns.
- Combines research, programmes, and evaluation.
- Involves various community stakeholders.
- UP "focuses on reducing those risk factors — and on promoting those protective factors — that are likely to increase the probability of preventing multiple (sometimes co-morbid) health outcomes, such as depression, eating disorders, and the abuse of cigarettes and other substances" (Levine 2017 p6).

Table 3.1 - Features of UP.

Jones et al (2017) outlined three key themes about UP in their introduction to a special issue of the journal "Eating Behaviours":

i) Public policy approaches to change norms

ii) Universal interventions to reduce risk and enhance protective factors

iii) Implementation of interventions and strategies

3.2. PUBLIC POLICY

Austin et al (2017) stated: "Individual-level

behaviour change is ultimately essential for eating disorders prevention, but the neglect of macro-environmental targets undermines the potential for large-scale population impact. Importantly, a number of other sectors of public health have embraced macro-environmental change strategies and achieved large-scale preventive effects (eg: prevention of accidental injury through seatbelt laws, reduction of dental caries through fluoridation of public water, reduction in smoking through tobacco taxation)" (p9).

They continued: "Over the past decade, research-to-policy translation – that is, using scientific findings to inform evidence-based policy action to improve population health – has become a priority focus for government, academic, and community public health professionals" (Austin et al 2017 p10). The translation from laboratory to clinical applications has been described as phases T1 and T2 by the US Institute of Medicine, while phases T3 and T4 have been added by others to "refer to activities aimed at large-scale application in health care, public health, and policy sectors" (Austin et al 2017 p10).

Austin et al (2017) described a case study from the USA involving Harvard University academics and local government officials called the "Strategic Training Initiative for the Preventing of Eating Disorders" (STRIPED) [9]. It could be classed as an example of phase T4. One focus was upon dietary supplements sold for weight loss and muscle building. Adolescents with disordered eating risk, and body dissatisfaction are more likely to use such supplements. This has been established from epidemiological studies (eg: Liechty and Lee 2013).

In 2013 STRIPED began a study of law and policy on these supplements, and a set of recommendations were generated (eg: age restrictions; legislation on deceptive advertising claims; legal bans). this led to a bill in Massachusetts in 2015 introducing age restrictions on the sale of dietary supplements. Expert advice, and campaigning under the heading "Stop Feeding Kids Lies" were employed, particularly when opposition came from trade lobby groups [10].

Sanchez-Carracedo et al (2017) reported the example of the "Roundtable on the Prevention of Eating Disorders"

[9] This programme fulfilled six of Levine's (2017) features of UP programmes (not focus on common risk factors in general population, not reducing risk factors associated with main health issue, and research, programme, and evaluation feature).

[10] The bill was not passed (https://www.naturalproductsinsider.com/legal-compliance/massachusetts-bill-banning-sale-sports-supplements-minors-dies).

in Catalonia, Spain, which included public and private health stakeholders. It was founded in 2012, and presented the "Decalogue of Best Practices for the promotion of self-esteem and positive body image in social media and advertising" in 2014. This was supported by journalists, and included the presentation of a variety of realistic and healthy body images, avoidance of promotion of high risk behaviours and unhealthy diets, and to protect children during the hours of their television programmes [11].

3.2.1. Disclaimer Label

Female body dissatisfaction has been linked to idealised images in the media. "This has generally been attributed to upward social comparison, whereby women compare their appearance with that of the idealised models and find themselves wanting... Recently, these ideals have been rendered even more unrealistic due to the common practice of digital altering and enhancing media images" (Bury et al 2017 p18).

One policy response in certain countries (eg: Australia) was to require a disclaimer label to be attached to any digitally altered media image. The rationale was that "a disclaimer label will highlight the appearance of a model as unrealistic and therefore inappropriate as a comparison target, thereby reducing social comparison and resultant body dissatisfaction" (Bury et al 2017 p18).

Is this so? The limited number of studies on the topic are contradictory (Bury et al 2017). It is possible that social comparisons are automatic. "Thus, it may be that the digital alteration message contained in a disclaimer label comes too late, after women have already spontaneously made their upward comparisons with the models. Hence providing women with information about digital alteration before exposure to thin ideal advertisements may better allow them to inhibit appearance comparison processing or cognitively prepare to 'mentally undo' inappropriate comparisons..., and thereby preserve body satisfaction" (Bury et al 2017 p19).

This is what Bury et al (2017) studied with 280 female undergraduates at a South Australian university. For half the participants a pre-exposure message was presented before the images: "As you may be aware, nearly

[11] This UP programme fulfilled eight of the nine features according to Levine (2017) (not the combination of research, programme, and evaluation feature).

all images in fashion magazine advertisements (like those you are about to view) are airbrushed or digitally altered to improve the appearance of the models in the advertisements" (p19). The other half saw a neutral message (control condition): "As you may be aware, there are many different types of magazines available such as fashion, gardening, celebrity news and gossip, home styling, craft and hobbies, parenting, lifestyle, television, pets and business" (p19). The participants then viewed fifteen fashion magazine advertisements (of which half of participants had a disclaimer label: "Warning: This image has been digitally altered"; p19). This meant that there were four independent conditions to this experiment (table 3.2).

	Disclaimer label attached to each image	No labels
Pre-exposure warning	1	2
Neutral message	3	4

Table 3.2 - The four conditions of the experiment by Bury et al (2017).

A number of outcome measures were used including body dissatisfaction (which were also completed before the experiment).

The study found no significant results. "Disclaimer labels did not reduce levels of perceived realism, social comparison, or body dissatisfaction. Likewise, a brief digital alteration informational message read before exposure to the fashion advertisements did not reduce perceived realism, social comparison, or body dissatisfaction in its own right, nor did it increase the effectiveness of disclaimer labels. However, regardless of pre-exposure message or disclaimer label, exposure to thin ideal advertisements did result in increased body dissatisfaction, with social comparison predicting the increase in body dissatisfaction, and perceived realism associated with increased social comparison" (Bury et al 2017 p21).

The researchers were not able to explain why the pre-exposure message or disclaimer label had no positive impact on body dissatisfaction, for example, and the study used a specific sample in terms of generalisation. But it seems that the policy of disclaimer labels may be of limited use. They can be likened to a small voice in

the midst of a loud cacophony of voices. In other words, the daily saturation of idealised body images that are seen by girls and women overwhelms any warning about the digitally altered and unrealistic nature of the images.

3.3. UNIVERSAL INTERVENTIONS

Body dissatisfaction in adolescents, particularly females, underlies many problems, including unhealthy eating behaviours, depression, and low self-esteem. Boyd image interventions at around twelve years old may be one possibility. Dunstan et al (2017) evaluated a programme called "Happy Being Me" (Richardson and Paxton 2010) in Australia [12]. The programme addresses individual psychological risk factors for body dissatisfaction, like internalising of "thin media body", and peer factors, like weight-related teasing.

Dunstan et al (2017) compared 200 female 11-14 year-olds at five schools in Melbourne. The schools were randomised to receive the programme as single-sex, co-educational, or no intervention. Various questionnaires were used to measure outcomes (eg: Physical Appearance Comparison Scale (PCAS); Thompson et al 1991).

There were significant improvements in body dissatisfaction and individual psychological risk factors (internalising of the thin ideal, appearance comparisons, and self-esteem) in the intervention groups at post-intervention, and at six months follow-up (except body dissatisfaction) (figure 3.1). There was no difference between single-sex and co-educational presentations.

The improvements in body dissatisfaction were not maintained at six months post-intervention follow-up, which is different to previous research (eg: Richardson and Paxton 2010), but follow-up was three months here (Dunstan et al 2017). Dunstan et al (2017) commented: "It may be that as the follow-up becomes longer the opportunity for new challenges to body image to arise increases, and booster sessions at regular intervals that address changing needs may be beneficial" (p29).

There was no improvement, however, in peer risk factors (eg: weight-related teasing).

Maladaptive cognitions related to weight and body image include "what I look like is an important part of who I am", and "when I meet people for the first time, I

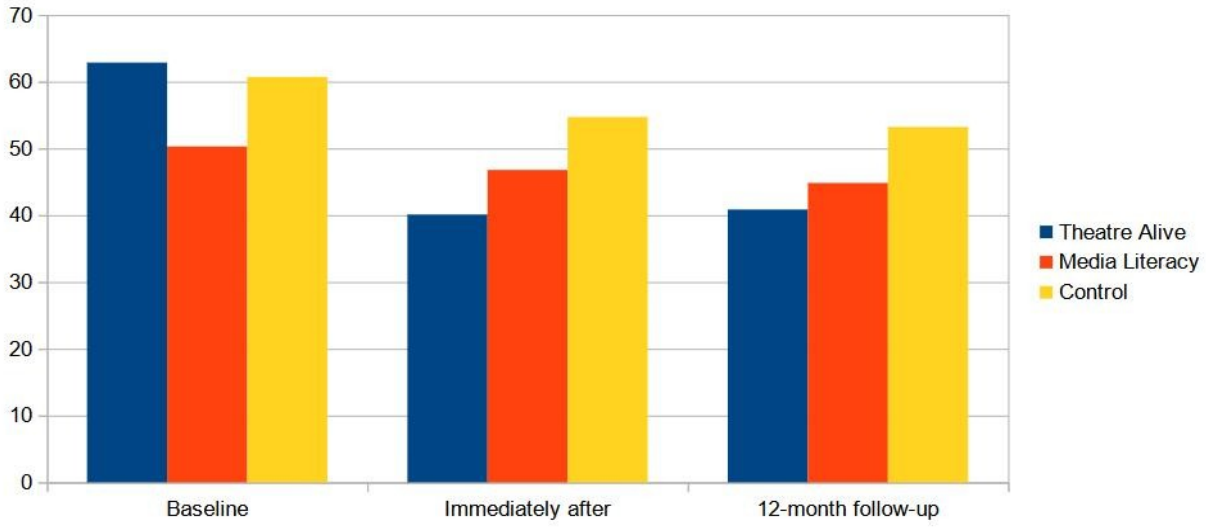
[12] Levine (2017) rated this programme as fulfilling four of the features of UP - not selective, focuses on risk factors in general population, includes asymptomatic individuals, and reduces other risk features than those related to the main health issue.

wonder what they think about how I look" (Mora et al 2017). These may be better predictors of disordered eating than body dissatisfaction (Mora et al 2017).

Mora et al (2017) described two UP programmes to address cognitive distortions. One programme combined nutrition information with media literacy to combat male and female aesthetic models in the media, while the other was "Theatre Alive" (role playing different scenarios). Both were tested in a city in Spain with 178 12-15 year-olds (including a control condition) over two months. Cognitive distortions were measured by a specific Spanish questionnaire on eating disorders (EDs) (with items like, "my ability to deprive myself of food proves I'm better than other people").

In their evaluation of the two programmes, Mora et al (2017) found a significant reduction in maladaptive cognitions linked to weight and body image in the "Theatre Alive" condition immediately after the programme and at 6- and 12-month follow-up (figure). The reduction in the media literacy condition was not significant.

The "Theatre Alive" and media literacy conditions were quite small (26 and 25 participants respectively).



(Data from table 4 p55 Mora et al 2017)

Figure 3.1 - Mean scores on measure of cognitive distortions related to weight and body image.

3.3.1. Anorexia Nervosa

Treasure et al (2015) described a model of the development of anorexia nervosa (AN) based on four stages:

i) "High risk" - individuals showing AN risk factors like obsessive-compulsive traits, and cognitive inflexibility.

ii) "Early syndrome" - early sign of symptoms like disordered eating, and weight concerns.

iii) "Full syndrome" - clinical diagnosis of symptoms.

iv) "Severe enduring illness" - living with the condition.

UP could work at the first stage. Adametz et al (2017) reported the example of "PriMa" (primary prevention of anorexia nervosa in pre-adolescent girls) [13]. PriMa is aimed at female 11-13 year-olds, and delivered by teachers over nine 45-minute sessions: "the girls discuss normal AN-related issues (ideals of beauty, rebellion, power), problematic issues (loss of control, distorted body image, suicidal thoughts) and clinical issues (rigid rituals of eating, weight phobia, depression)" (Adametz et al 2017 p43). Cognitive dissonance is the psychological theory behind this programme.

PriMa has been evaluated in the short-term (Wick et al 2011). But as Adametz et al (2017) explained: "At this age, baseline values of disordered eating were low and body self-esteem was quite good... Therefore, treatment effects are unlikely, because it is difficult to achieve statistically significant differences in body self-esteem and disordered eating in these cases... Furthermore, the incidence peak of AN is around 15 years..., suggesting that changes in disordered eating and body self-esteem occur during this peak risk period. Therefore, an evaluation over the entire length of the risk period with an adequate follow-up duration is necessary to capture long-term programme effects of universal prevention" (p44).

Thus, Adametz et al (2017) followed up online Wick et al's (2011) sample of 1508 females 7-8 years later. A

[13] There was also "Torera" (prevention of disordered eating in terms of bulimia nervosa and binge eating disorder) for both boys and girls of the same age (Berger et al 2014).

sample of 100 participants completed the questionnaire (of which 37 had been the control group). The PriMa programme participants had higher values of body self-esteem, and lower values of disordered eating than the control group. Body self-esteem was a stronger relationship. "Following the analysis of these changes of body self-esteem over time, it was found that the intervention group revealed an increase of body self-esteem after programme participation and remained stable over time. By contrast, the control group revealed a decrease of body self-esteem over time" (Adametz et al 2017 p42). Put simply, Prima prevented a decrease in body self-esteem over the teenage years.

Despite this study being "the first study in the area of prevention research of ED to evaluate a prevention programme seven to eight years after implementation" (Adametz et al 2017 p49), the sample was less than 7% of the original participants. The data were self-reported answers to an online survey.

3.4. IMPLEMENTATION OF INTERVENTIONS

Wilksch (2017) outlined three issues related to implementation of UP school programmes:

i) Single vs multiple sessions - A meta-analysis by Stice et al (2007), for example, found that multiple sessions had a larger statistical effect. "This makes sense given the importance of consolidating learned content, practising skills, and time for interactive learning activities" (Wilksch 2017 p58).

However, early studies of single session programmes had methodological weaknesses, including that "many were delivered in a didactic rather than interactive manner, which has also been shown to be associated with smaller effect sizes" (Wilksch 2017 p59).

Wilksch (2017) argued that single session programmes still had a place, if schools are discouraged from using multiple session programmes. Diedrichs et al (2015), for example, found that a single ninety-minute session delivered by a teacher was better than by an expert researcher in terms of post-programme measures of body esteem, and dietary restraints, for example.

ii) Articulating the purpose of UP - "Weight concern", for example, is a better indirect measure of ED risk. "It has been proposed that body dissatisfaction is heavily influenced by mood and is thus of a more labile

nature whilst weight concerns are a more stable construct that includes the value placed on one's body weight and shape to an individual's self-worth... [Also] weight concerns and over-valuation of weight and shape are clinical and diagnostic features of patients with an eating disorder" (Wilksch 2017 p59). Body image programmes have their benefits, but not necessarily with ED risk (Wilksch 2017).

iii) Establish scientific findings - "Prevention scientists are in a constant tension between pursuing methodologically rigorous scientific research whilst also being well aware of the 'real world' limitations in which this work is conducted. Nowhere is this more apparent than in universal, school-based research. Universal prevention scientists need to find an appropriate balance between quality efficacy research, whilst also not taking years to accrue this..." (Wilksch 2017 pp59-60). Furthermore, how to disseminate the findings from randomised controlled trials into intervention programmes?

Wilksch (2017) ended: "The universal eating disorder risk reduction field is continuing to advance and there have been many valuable steps forward in recent years... Whilst the field needs to continue with quality scientific output..., we also need greater attention towards dissemination of programmes with an evidence-base... Strategies including investigating shorter programmes, developing a clearer case for prevention of core eating disorder features and weighing up effectiveness research versus specialist programme delivery on a broad scale are all likely to help. In the end, the main aim of our research is to benefit as many young people as possible. We thus must give greater attention to how this can be achieved" (p60).

Other groups can be involved in delivering programmes. For example, "The Body Project" (TBP) is, as Becker et al (2017) explained, "a cognitive dissonance-based intervention in which young women voluntarily critique the thin-ideal standard of female beauty via verbal, written, and behavioural exercises [14]. This theoretically creates the uncomfortable psychological state of cognitive dissonance, which prompts participants to reduce thin-ideal internalisation because people are motivated to align their attitudes with their

[14] Levine (2017) rated this programme as characterising seven features of UP programme (not involves public institutions, and media campaigns to change norms and attitudes).

behaviours... Reduced thin-ideal internalisation putatively decreases body dissatisfaction, eating disorder symptoms, and eating disorder onset" (p63). Studies, including with a three-year follow-up, report a reduction in ED onset (Becker et al 2017). Becker et al (2017) outlined the dissemination of TBP through various means including universities, and non-profit groups like the "Eating Recovery Centre Foundation" in the USA.

REbel (Breithaupt et al 2017a) is another programme that uses cognitive-dissonance based prevention techniques for ED symptoms, but also empowerment. Young participants are encouraged to develop ideas that challenge the thin ideal, while increasing self-esteem and body image (Breithaupt et al 2017b).

The purpose of REbel is "to function seamlessly within a school system and be self-sustaining, targeting the highest risk group in the most cost-effective manner" (Breithaupt et al 2017a p33), while using empirically supported principles, including on empowerment. Breithaupt et al (2017a) explained the name "REbel", as "based on the idea that we are encouraging students to 'rebel' against the unrealistic standards for appearance set forth by our culture (ie the thin ideal), the diet mentality, and conformity. Also important, is the focus on teaching students to 'be' aware, informed, critical consumers, and agents of change in their communities" (p33).

Breithaupt et al (2017b) performed an evaluation study at seven high schools in the Midwest USA. A total of 86 14-18 year-old females joined the "after-school clubs" for eight months (a school year). Various measures were taken before and after (eg: Body Esteem Scale for Adolescents and Adults; BESAA; Mendelson et al 2001).

Overall, there was a decrease in ED risk factors, and an increase in empowerment. The former includes body checking symptoms, internalisation of thin ideal, and body esteem.

There was no control group. The schools that participated were volunteers and in favour of the programme. Another problem, Breithaupt et al (2017b) accepted, was that "[W]e were not able to assess for eating disorder symptoms due to school-board constraints" (p40).

3.4.1. Treatment-Seeking

Lipson et al (2017) focused on reasons for not

seeking treatment for ED symptoms. The "Healthy Bodies Study" (HBS) was undertaken in 2014 at two US universities with 2180 volunteers. Various questions were asked about weight concerns, and ED symptoms, as well as willingness to seek treatment for EDs.

Around one-third of the sample were classed as potentially having an ED, but only 14% of them had received treatment in the previous year. Among those who did not seek treatment, "the most commonly reported reasons for not seeking help were: 'I have not had a need for counselling/therapy' (41.7%), 'I prefer to deal with issues on my own' (27.6%), 'I'm not sure how serious my needs are' (19.9%), and 'I don't have time' (19.5%). Only small proportions of students with untreated symptoms reported traditionally-emphasised barriers such as stigma, lack of knowledge, and financial limitations. Just 4.1% reported 'I worry about what others will think of me'" (Lipson et al 2017 p70).

These findings suggested to the researchers that a key barrier to accessing help around ED symptoms was that "students are not seeking treatment because they do not think they need it" (Lipson et al 2017 p72). Lipson et al (2017) continued: "Efforts should concentrate on increasing perceived need and convincing students of their need for treatment. Our findings suggest that the focus, both in research and practice, should shift from anti-stigma campaigns and other common strategies to universal prevention initiatives that educate students about the severity of EDs and provide convenient and relevant options" (p72).

3.4.2. Universal Screening

The SCOFF questionnaire (Morgan et al 1999) is a short measure (five yes/no items) for screening for disordered eating, first developed for use with individuals with EDs (Richter et al 2017). It is possible to use it as part of a general population survey.

Richter et al (2017) reported such use in Germany as part of a general survey of over 4600 households in 2014. A score of ≥2 (out of 5) was used as the cut-off for disordered eating, and 10% of the sample was classed thus.

Comparing the SCOFF responses (table 3.3) to questions from the "ICD-10 Symptom-Rating" (ISR-E) in the survey, it was calculated that around three-quarters of "at risk" individuals scored below 2 (ie: false negatives), and about one-third of scorers of ≥2 were not

"at risk" from disordered eating (ie: false positives). "The performance of the SCOFF was lowest for men aged 14–29 years and men aged 70 years and older, revealing difficulties in detecting disordered eating in these sub-samples" (Richter et al 2017 p86).

The validation of SCOFF was made against another self-report measure, not formal diagnosis. In terms of the usefulness of SCOFF, it focuses on certain issues and ignores others.

The researchers were pessimistic about the use of (the German version of) SCOFF as a universal general population screening measure for disordered eating - it is a "sub-optimal measure" (Richter et al 2017 p87).

- 1. Do you make yourself sick because you feel uncomfortably full?
- 2. Do you worry you have lost control over how much you eat?
- 3. Have you recently lost more than one stone in a three month period?
- 4. Do you believe yourself to be fat when others say you are too thin?
- 5. Would you say that food dominates your life?

(Source: Table 3 p85 Richter et al 2017)

Table 3.3 - The SCOFF questionnaire (as used for German translation by Richter et al 2017).

Kass et al (2017) advocated a UP programme that covered the shared risk and maintaining factors for EDs and obesity. These researchers confirmed the overlap between the two groups in a survey of 1529 students at two US universities. The "Stanford-Washington University Eating Disorder (SWED) Screen" (Jones et al 2014) was completed. This is a brief online measure that covers ED behaviours and risks, which items like, "Have you made yourself throw-up?", and "Have you fasted (intentionally not eaten anything at all for at least 8 waking hours)?" (p75).

Based on total scores, individuals were categorised as low risk, high risk, or "warranting a clinical referral", and divided based on under-, normal or overweight. Similar numbers of underweight and overweight respondents were classified as "warranting a clinical referral" (8.1% and 9.4% respectively). More overweight

individuals were classed as high risk than the other two weight groups.

The study showed the importance of UP programmes as overweight individuals can have the disturbed eating behaviours seen in EDs usually associated with underweight.

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4. GOOD FOODS

4.1. IMMUNE SUPPORT FOODS

"Immunity support" foods and drinks, are increasing on supermarket shelves (eg: 2% of new products globally in 2020 used such a term on the packaging; Nahas 2022). They claim in various ways to help the body's defences against infections.

"The impact of diet on our natural defences is a topic rife with claims that don't stand up to scrutiny, but we are finally developing a clearer picture of the powerful influence that food can have on our immunity. The surprising truth is that focusing on particular products or ingredients could be leading you down the wrong path" (Nahas 2022 p47).

Finding definitive answers is not easy because of the complexities of the immune system, and the testing of cell cultures and animals in laboratories is very different to real-world settings with humans.

It is clear that deficiencies, in vitamins say, can hamper immune function, but extra doses for non-deficient individuals do not necessarily give extra benefits (eg: vitamin C).

One area of promise is the microbiome (the bacterial community in the gut), which interactions with the immune system. "The gut microbiome plays a major role in 'training' the immune system, and changes in microbiome composition or activity may affect activity of several immune cell types (lymphoid, myeloid). These effects may be mediated in part by direct exposure of developing immune cells in situ in the gut, or by the production of different microbial metabolites that can act in other organs distant from the gut" (Finlay et al 2021 p3). For example, Schluter et al (2020) showed, in a study of over 2000 people, that immune cells in the blood varied with bacterial strains in the gut.

Wastyk et al (2021) studied the effects of a ten-week high-fermented or high-fibre diet on the immune system with 36 healthy adults in the USA. Both diets changed the microbiome, but the fermented diet "steadily increased microbiota diversity and decreased inflammatory

markers" (Wastyk et al 2021 p4137).

Gut microbial diversity has been reduced in the last century "because of many processes and practices: increased urbanisation; overuse of antibiotics and other medications; birth and infant feeding practices; intensified hygienic practices that disinfect bodies, homes, and workplaces; reduced diversity in global diets (especially declining intake of dietary fibre and increased consumption of processed foods); and widespread use of tobacco, alcohol, and other drugs" (Finlay et al 2021 p2). Covid-19 may have accelerated these changes (Finaly et al 2021) (table 4.1).

- Increased hygiene, and use of anti-microbials
- Changes in diet and food consumption, including timing, quantity, quality, and frequency
- Reduced social interactions

Table 4.1 - Ways in which covid-19 pandemic may reduce gut microbial diversity.

One consequence is the extinction of microbial species that have lived in (with) humans. This is known as the "disappearing microbiota hypothesis" (Blaser and Falkow 2009). "Reduced microbial exposure resulting from diverse social changes and associated increases in host inflammation have been linked to rising rates of chronic diseases, including obesity, diabetes, asthma, and various auto-immune diseases. Disruption of the microbiome predisposes us to multiple seemingly non-transmissible human diseases" (Finlay et al 2021 p2). This idea was first proposed in the "hygiene hypothesis" (Strachan 1989).

4.1.1. Blueberries

Blueberries are high in polyphenols, and these are known to give cardio-vascular and cognitive health benefits, particularly for older adults.

Wood et al (2023) performed a double-blind, parallel randomised controlled trial with sixty-one healthy older adults (65-80 years old) in London with freeze-dried wild blueberry (WBB) powder (or a placebo). Daily WBB consumption was expected over twelve weeks, while normal

diet was followed. Baseline measures were taken, including blood pressure, blood sample, faecal sample, and cognition.

The WBB group showed benefits on the majority of measures at the end of twelve weeks compared to the control group, except gut microbiota composition and cerebral blood flow which did not change.

"In conclusion, long-term consumption of a dietary achievable amount of WBB was observed to enhance vascular and cognitive function in older adults and may be a plausible and cost-effective dietary-based strategy to tackle the burden of age-related cognitive decline and vascular dysfunction" (Wood et al 2023).

4.2. PROBIOTICS

A probiotic pill containing the gut bacterium Hafnia alvei has been found to mimic an appetite-suppressing hormone, with the upshot of weight loss (Wong 2022).

A study in France with over 200 obese individuals taking this pill or a placebo over three months found a weight loss of at least 3% of baseline body weight in 55% of the former group (compared to 41% of the placebo group) (Pierre Dechelotte at the "Targeting Microbiota 2022" conference reported in Wong 2022) [15]. Lower appetite was reported by the pill group.

"But the effects of probiotics differ depending on our genetics, gut microbiome and overall metabolism... Ultimately, we would need a personalised approach to prescribe probiotics to minimise any side effects" (Adele Rakotonirina in Wong 2022).

4.3. ALMONDS

More studies are being performed on diet and gut microbiota, and there is strong evidence for the importance of fibre (dervied from plant foods and including macro-nutrients, micro-nutrients and non-nutrient bioactives) (Creedon et al 2022).

Creedon et al (2022) argued for studies on specific foods and gut microbiota, and so focused on almonds. Previous randomised controlled trials lack consensus due to methodological limitations, like lack of blinding or masking of food or control, and insufficient wash-out periods (Creedon et al 2022).

Eighty-seven healthy adults who snacked regularly,

[15] See also https://www.intechopen.com/chapters/80869.

and did not have a high-fibre diet were recruited in London. The study lasted four weeks (free-living - ie: not in a controlled environment), and participants were randomly allocated to one of three conditions - whole almonds, ground almonds, or an energy-matched muffin (control). The participants were required to snack twice a day, and the gut microbiota assessment came from self-collected stool samples.

There was a limited impact of almonds (whole or ground) on gut microbiota.

There were a number of methodological considerations with this study, including:

i) The study was an independent groups design, which meant participation in one condition only. This avoids interference between conditions and wash-out periods, but the groups may not be comparable in terms of individual differences.

ii) The participants were volunteers who responded to advertisements at London universities and in the locality. There were clear inclusion and exclusion criteria. The age range was 18 to 45 years, with an average age of 28 years old, but 88% were female.

iii) The participants continued with their daily lives during the four weeks of the study, which meant potential confounders and uncontrolled variables compared to keeping the participants in a controlled laboratory environment throughout. The measured confounders were diet, body composition, and body mass index. Also the study was dependent on the compliance of the participants in terms of eating (estimated at around 90% overall), and stool collection. Complete data were available for 79 participants.

iv) "Blinding of participants to the intervention was not feasible for numerous reasons: almonds are easily identifiable; it was impossible to design a placebo identical to almonds, but without any active components; and it was necessary to exclude participants who had an allergy/intolerance or dislike to almonds. However, all efforts were made to mask participants to the true intervention by advertising the trial as a 'snack replacement trial' testing the impact of a variety of snack foods on gut health, and avoiding any mention of almonds in advertising materials. Researchers were blinded to intervention allocation for data analysis through recoding of participant data" (Creedon et al

2022).

v) The study lasted four weeks, whereas others have lasted longer (eg: eight weeks). Long-term impact studies (eg: six months) are required as well as those that vary the dose of almonds (Creedon et al 2022).

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5. DISORDERED EATING AND UNDERSTUDIED POPULATIONS

5.1. MILITARY VETERANS AND ATYPICAL ANOREXIA NERVOSA

Atypical anorexia nervosa (AAN) appears in DSM-5, and it is a category not as "severe" as anorexia nervosa (AN) - in particular, sufferers have a normal weight range or above (compared to underweight and severe underweight in AN) (Masheb et al 2021).

Using data from the "Women Veterans Cohort Study" (WVCS), Masheb et al (2021) investigated the prevalence of AAN. A random sample of male Veterans was also included for comparison. Over 1100 Veterans who were discharged from military service between 2001 and 2018 were recruited. Various measures of eating behaviour, and general mental health were completed, along with height and weight for body mass index (BMI) calculation (all self-reported). "Probable AAN" (ie: formal diagnosis not possible) was based on answers to the "Eating Disorder Diagnostic Scale-5" (EDDS-5).

It was found that 13.6% of the female participants and 4.9% of the men met the criteria for AAN (and 19.2% and 13.9% respectively had another eating disorder probable diagnosis). The researchers commented that "there is no reported population prevalence for AAN so it is difficult to provide context" (Masheb et al 2021 p5) for these figures. But the prevalence of AN in the USA is less than 1% (Masheb et al 2021).

Three groups were distinguished for comparison - AAN, other eating disorder, and no eating disorder (NO). Few significant demographic differences were found. For example, the NO group was slightly older than the other two groups (mean 44 vs 41-42 years).

The AAN group had a significantly greater highest BMI (though not current BMI), greater weight suppression (ie: current weight at least 10% less than highest weight), more frequent dietary behaviours in the last month, and dietary restraint behaviours.

The findings confirmed a picture of AAN as individuals overweight (or high normal range BMI) who

focused on losing a large amount of weight in different ways. Masheb et al (2021) raised "the question of how AAN differs from successful dieting and weight loss efforts" (p6). In another study, Forney et al (2017) found the cognitive impairments of AN in the AAN sufferers. It is possible that AAN sufferers are not able to achieve the low weight required for AN diagnosis. "There are physiologic and behavioural factors involved in ageing and body type that are at odds with holding unusually low weight" (Masheb et al 2021 pp5-6).

Masheb et al (2021) found no cases of AN. Was this a product of self-report measures, of older participants than the typical adolescent and young adult sufferers, or the long-term consequences of military fitness training?

Masheb et al (2021) concluded thus: "Our findings highlight that eating disorders have been masked in the military and Veteran population and that the AAN diagnosis has potential importance for other underserved and under-represented populations. Results suggest that AN may be primarily a disorder of adolescence and young adulthood, whereas AAN may in fact be a disorder of adulthood that is actually not so atypical after all" (p7).

5.2. SEXUAL AND GENDER DIVERSE

Among US college students, around 14% of women and 4% of men have a clinical eating disorder (ED), while between 20-67% of the others (depending on the study) report ED symptoms (Grammar et al 2021).

Recent research has suggested that "young adults who identify as sexually diverse (SD) (ie: those who do not identify as heterosexual) and/or gender diverse (GD) (ie: those whose sex assigned at birth is discordant with their gender identity or who have diverse gender identities/gender expressions) are at increased risk for EDs and ED symptoms" (Grammar et al 2021 p2).

Grammar et al (2021) showed these observations with data from over 8500 students at nine US universities who completed an online survey on health and well-being. The important questions here were:

- Sexual orientation - heterosexual, lesbian, gay, bisexual, queer, questioning, or other.

- Gender identity - male, female, trans male/trans man, trans female/trans woman, genderqueer/gender non-conforming, or other.

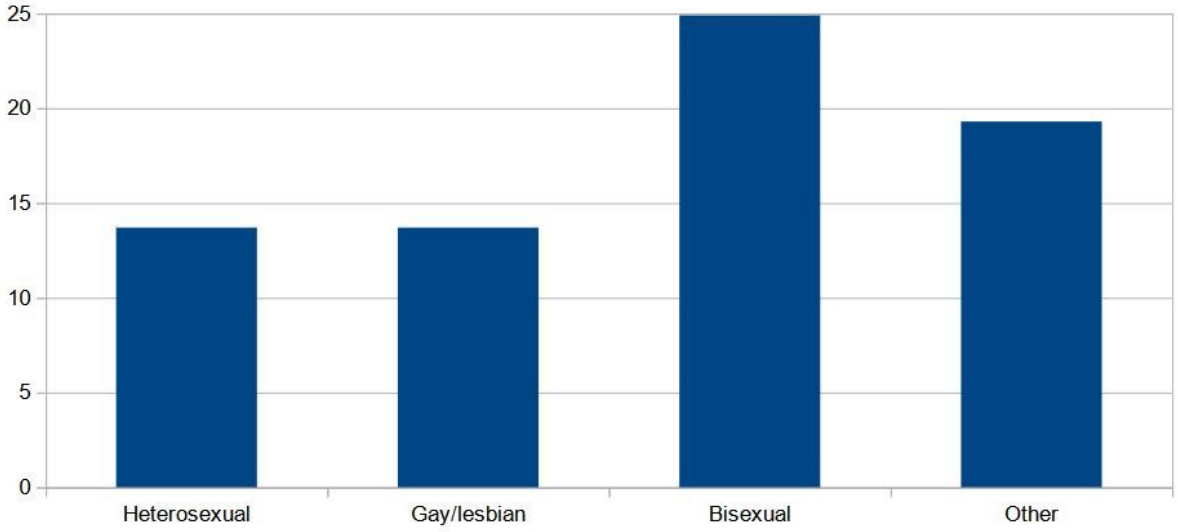
- Probable ED diagnosis - "Stanford-Washington University Eating Disorder Screen" (SWED): eleven items covering behaviours like binge episodes, and vomiting and/or laxative use to control weight.

- Weight and shape concerns.

- Other probable psychiatric diagnoses.

Overall, 24% of the sample identified as SD, and 2.7% as GD. Analysis of answers was based on two groups in the main - SD vs heterosexual, and GD vs male/female (cisgender).

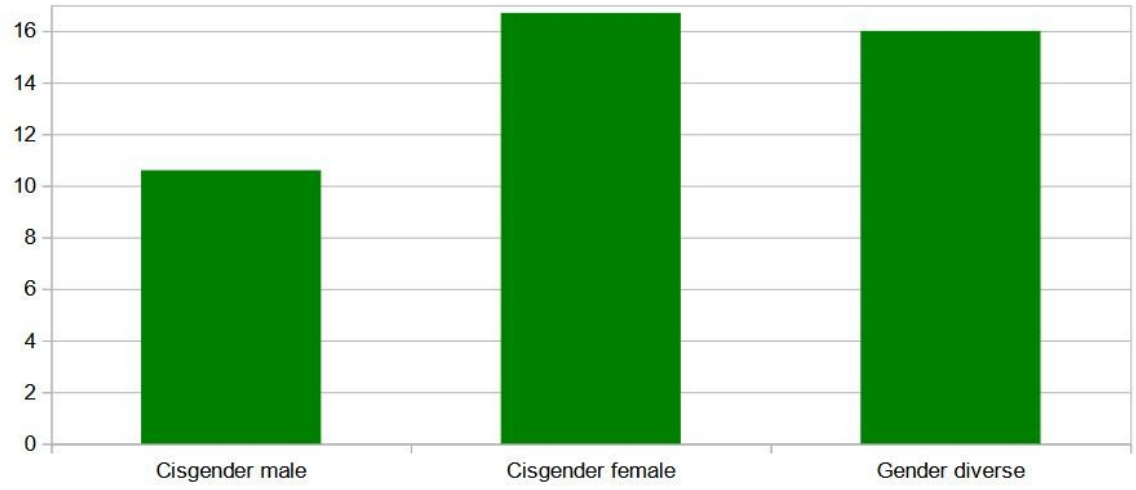
Firstly, based on sexual orientation, SD individuals were more likely to have a probable ED diagnosis, ED symptoms, and weight and shape concerns than heterosexual students. Bisexual students were particularly at risk (figure 5.1).



(Data from table 2 Grammar et al 2021)

Figure 5.1 - Probable eating disorder (%) based on sexual orientation.

Based on gender identity, GD students had a greater odds of a probable ED diagnosis than cisgender students (figure 5.2). Weight and shape concerns, and ED symptoms were less common among cisgender males compared to all other students.



(Data from table 2 Grammar et al 2021)

Figure 5.2 - Probable eating disorder (%) based on gender identity.

The study had a large, geographically diverse sample. Sexual orientation and gender identity were based on self-identity, and all data were self-reports. But there was, Grammar et al (2021) explained, "the inability to examine the interaction between sexual orientation and gender identity on ED diagnoses, due to a limited sample of students simultaneously belonging to SD and GD groups. Similarly, we were unable to independently examine several S&GD sub-groups, including students who identified as queer, endorsed two or more sexual orientations, questioning, or gender-queer/gender non-conforming" (p5).

Eating-related psychopathology among GD individuals generally has been little researched, but Uniacke et al (2021) distinguished two points from the literature:

a) Individuals undergoing/underwent gender-affirming interventions report fewer ED symptoms and less body dissatisfaction than individuals not having/had such interventions.

b) Minority stress (ie: "additional stress experienced by marginalised groups due to stigma and discrimination"; Uniacke et al 2021 p1) increased body

image and ED problems.

Uniacke et al (2021) performed a secondary analysis on data from "Project AFFIRM", which is a longitudinal study in the USA of transgender and gender non-binary individuals. Participants self-categorised as woman (n = 39), man (n = 19), transgender woman/male-to-female (TGF) (n = 77), transgender man/female-to-male (TGM) (n = 74), non-binary (n = 41), genderqueer (n = 34), or another (n = 3). A variety of questions were asked about disordered eating behaviour, and body image, as well as gender identity, and minority stress.

Around half of all participants reported at least one disordered eating or problematic behaviour in their lifetime. The most common was loss of control eating, followed by compulsive exercise. Eighty-three individuals met the criteria for ED symptoms currently, and these individuals had a higher BMI, increased minority stress (or internalised transphobia), and were more likely to be currently undergoing gender-affirming psychotherapy than the rest of the sample. Concerning the latter factor, Uniacke et al (2021) stated: "We do not believe this finding reflects a causal relationship between psychotherapy and subsequent eating-related symptomatology, but rather suggests that these individuals may be struggling more and thus pursuing treatment" (p5). Transgender congruence (ie: the congruence between gender identity and appearance) was also important, "such that individuals who reported more congruence between their gender identity and external appearance were less likely to report eating-related symptoms" (Uniacke et al 2021 p4).

The transgender and non-binary groups varied significantly on one behaviour - "More gender non-binary participants reported a lifetime history of self-induced vomiting... than TGF or TGM individuals. The groups did not otherwise differ in the presence or frequency of disordered eating symptoms" (Uniacke et al 2021 pp3-4).

Disordered eating behaviours, and weight and shape issues overall were higher than the cisgender averages.

Hartman-Munick et al (2021) performed another secondary analysis of US data. This time from the "Body image and Resilience study to Improve Gender-inclusive Health interventions for Trans communities" (BRIGHT) project, and the researchers concentrated on qualitative data.

In 2019 sixty-six participants were involved in online focus groups discussing appearance, and eating

behaviours. About half of them self-disclosed ED screening and/or treatment. The researchers elicited three themes (with sub-themes) from the discussions:

i) Barriers to ED screening/treatment - The cost was the most common barrier mentioned. A sub-theme related to the gender-based stereotypes of EDs as a problem for cisgender girls/women. A trans woman said: "Eating disorders are often seen as this thing that 'only affects girls', so when they happen to pre-transition trans women and [non-binary] people, they're often ignored or not taken seriously" (p3).

A gender non-conforming participant voiced another concern (fitting the sub-theme of ED treatment and gender affirming practice): "Treating ED[s]... can run directly up against interventions for tgnc [transgender/gender non-conforming] people. So... if you have an ED... you are often encouraged to practice radical body acceptance or do a lot of body meditations/somatic work where you are trying to push yourself to be in your body. While this works for many cis people, this is sort of the exact opposite of what works for tgnc people, allowing us to make choices about our body changes and helping us live with the dissonance between our bodies and brains" (p3).

ii) Complexity of the relationship between EDs and gender dysphoria - Gender dysphoria is the conflict felt between the preferred gender and the assigned sex at birth, and there were contradictory views about that and EDs expressed. One side saw gender dysphoria as contributing to the development of EDs, while others perceived no relationship between the two. The former view is encapsulated by one trans man: "My eating disorder started as a way to stop [menstruation] and breast development, so access to binders, hormone blockers/HRT [hormone replacement therapy] and gender affirming [care] would have helped me more when I was younger than therapy surrounding body image" (p4). While another trans man disagreed: "I have yet to find anything that helps my body image stuff. Years of therapy and all of the tricks of my current therapist, still nothing... It goes beyond being trans... I think part of the issue is everyone tries to focus on my dysphoria, when that hasn't been all that bad since I've had top surgery and been on hormones. It's everything else" (p4).

iii) The need for ED services to be trained about GD individuals - A non-binary participant stated: "They need to know that transgender and [non-binary] young adults

can have eating disorders... I can 100% say that as an adolescent and as an adult, I have never been asked my gender or information about my diet/eating history by a healthcare provider. This is a HUGE oversight that happens way too often [within] healthcare settings" (p4).

Understanding the unique experiences and physiology of GD individuals were sub-themes here. For example, a trans man said: "In terms of eating concerns, it would be really helpful to have nutrition advice available for people who don't have binary hormone systems (do I follow men's advice? Women's?)" (p4).

Hartman-Munick et al (2021) concluded that ED and GD require health care providers to address barriers and provide particular services for such individuals.

5.3. MULTI-RACIAL STUDENTS

Burke et al (2021a) investigated multi-racial US students (ie: those"identifying with more than one racial/ethnic group"; p1). Data were taken from the Healthy Minds Study (an annual online survey involving 199 higher education institutions) between 2014 and 2019 (n = 145 379). Overall, 7.7% self-identified as multi-racial. ED pathology was based on the five "SCOFF" questions ("Do you believe yourself to be fat when others say you are too thin?") (with a cut-off of ≥2) (Morgan et al 1999).

The prevalence of ED pathology ranged from 18.4 - 33.9% for mono-racial groups compared to 16.5 - 36.1% for multi-racial groups. By using the prevalence of each ethnic/racial group alone and combining them to give the expected prevalence for multi-racial groups, it was found that most multi-racial groups were significantly higher than expected. This suggested that "dual identity has its own specific implications for ED pathology, above and beyond that associated with separate [identity]..." (Burke et al 2021a p4). Prevalence rates among the American Indian/Alaskan Native, and Hispanic/Latinx groups were particularly higher than expected, while certain groups were unexpectedly low (eg: Asian American/Asian & White). "Although some of these patterns differed by gender identity, findings of higher than expected prevalence among multi-racial individuals identifying as African American/Black & White and lower than expected prevalence among multi-racial individuals identifying as Middle Eastern/Arab/Arab American & White were consistent across cisgender men and women" (Burke et

al 2021a pp5-6).

The findings "point to the critical need to develop a more fine-grained appreciation of the ways in which identities combine to influence ED outcomes" (Burke et al 2021a p6).

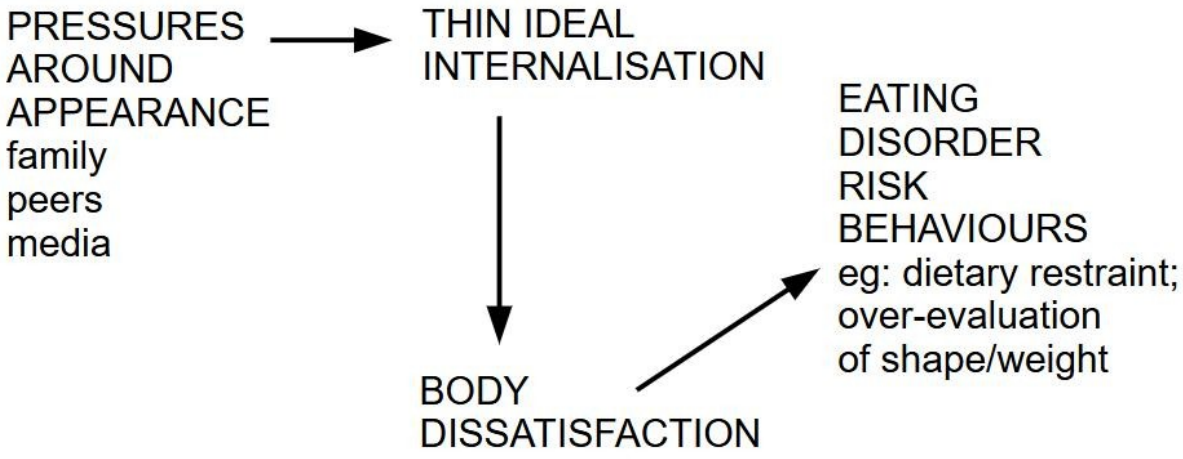
Some of the multi-racial groups were small (eg: African American/Black & Asian American/Asian = 135 participants), especially when analysing gender diversity. Identity variables like sexual orientation, and weight status were not included in the analysis. This could be important because intersectional approaches (Burke et al 2020) emphasise how different aspects of identity "may operate in concert to increase or decrease risk for outcomes of interest, including ED pathology... The intersectional lens acknowledges that the impact of one aspect of identity on illness risk may be moderated by other elements of one's identity" (Burke et al 2021a p2).

Related to this work, Burke et al (2021b) observed: Eating disorders are considered by many to primarily affect White women, despite evidence to the contrary... However, most theoretical models of eating pathology were developed and initially validated with primarily White females, overlooking the unique experiences that may impact eating disorder risk in racial/ethnic minorities" (p1).

One such model is the "tripartite influence model" (TIM) (Thompson et al 1999). Appearance-related pressures (via family, peer, and media) lead women to thin-ideal internalisation (which is mostly unattainable), and thus body dissatisfaction (figure 5.3).

Burke et al (2021b) investigated the TIM with 1758 US female undergraduates who self-identified as White, Black, Latina, or Asian. Various standardised questionnaires on body image and appearance, and EDs were completed.

Though there were differences in the risk factors between the ethnic groups (eg: Black women reported the lowest levels of shape/weight over-evaluation and body dissatisfaction), there were more similarities, which suggested the usefulness of the TIM for all the women.



(Based on figure 1 Burke et al 2021b)

Figure 5.3 - Tripartite Influence Model.

5.4. PICKY EATERS

"Picky eaters" may consume less than twenty different items across a lifespan (Annette and Stafford 2023). "Such restricted diets can lead to nutritional deficiencies in iron, zinc, and fibre..., as well as health problems like heart disease, poor bone health (osteoporosis) and dental issues... Additionally, there is also a social cost in that as eating is a social activity, normally enjoyable moments between family members can easily turn into stressful, anxious, and conflict-causing situations when picky eaters (PE) feel ashamed or pressured to eat food" (Annette and Stafford 2023 p1).

How to encourage PE to consume foods usually avoided? One solution is via "molecular gastronomy, a branch of food science, focuses on the manipulation of multi-sensory factors through physical and chemical processes during cooking and eating... Modifications to colour, sound and smell can enhance or diminish taste qualities, changing an individual's perception and overall preference for a dish" (Annette and Stafford 2023 p1). Research has focused on music/sounds playing while eating (eg: congruent sounds - ocean sounds while eating seafood), food texture in the mouth, and smell (Annette and Stafford 2023).

Colour is another variable. One study (Harrar et al

2011), for instance, found that popcorn was perceived as sweeter when served in a red than black bowl.

Annette and Stafford (2023) applied this finding to their study of 47 students at a university in England. Food pickiness was measured by the "Food Neophobia Scale" (Pilner and Hobden 1992) (eg: items: "I am very particular about the foods I eat"), and the "Food Choice Questionnaire" (Steptoe et al 1995). Participants were asked to taste and rate crisps presented in a red, blue, and while bowl.

Based on questionnaire responses, twenty participants were classed as PE, and the remainder as non-PE. Analysis was based on comparing the two groups on ratings of saltiness, desirability, and flavour intensity (out of 100).

Saltiness was rated significantly higher in the blue and red than while bowl by PE. There was no difference for the non-PE group. Desirability was highest in the blue bowl for PE only. There was no difference for flavour intensity.

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6. GLYCAEMIC INDEX, AND DIABETES

6.1. GLYCAEMIC INDEX

The glycaemic index (GI) was developed to score foods based on how quickly they increased blood sugar levels. A higher score means a more rapid rise in glucose levels in the blood (Wade 2022). Jenkins et al (1981), who developed the GI, defined it technically as the "incremental area under the blood glucose response curve (AUC) of a 50-g available carbohydrate portion of both a test and reference food consumed by the same individual over a 2-h period, expressed as a percentage" (quoted in Matthan et al 2016). Originally designed for individuals with diabetes to improve their glycaemic control and choice of foods with low (<55), medium (56-69) and high (>70) GI categories. "However, use of GI has gone beyond this original intent and is now being endorsed for use as a labelling tool to guide food choices to reduce chronic disease risk and serves as the basis for many popular diets (eg: South Beach and Zone). Although there are some clinical data to support a modest benefit of low GI and GL diets in the management of diabetes, in the non-diabetic population the evidence is mixed" (Matthan et al 2016 p1004).

There are methodological problems, particularly in non-diabetic populations. "The GI value is considered to represent the inherent property of the food and not the metabolic response of an individual to the food. Thus, theoretically GI values should be reproducible within and among individuals. However, a review of the published GI tables, which is a compilation of the GI values of individual foods generated by several laboratories , indicates different estimates for the GI value within a category and even for the same food. This could result in a food being ranked as low by one laboratory and high by another" (Matthan et al 2016 p1005).

Matthan et al (2016) showed different glycaemic responses in 63 healthy US adults to the same food (white bread). Twelve blood samples were taken in a six-hour period of study.

The mean GI value for white bread was 62 (medium) using standardised measurement. But the researchers

variations between individuals. In twenty-two of the participants, a low GI was measured (range: 35-55), medium (57-67) in 23 individuals, and eighteen individuals a high GI (70-103).

Such differences in GI for the same food are a product of differences between individuals, and in variables like food processing or preparation method, other foods consumed at the same time, and meal consumption patterns (Matthan et al 2016).

6.2. PRE-DIABETIC

"Resistant starch" (RS) is not broken down by digestive enzymes, and in the large intestine it undergoes fermentation by the microbiota. Five types of RS have been distinguished from foods like seeds, whole grains, raw potatoes, and green bananas (Maiya et al 2022).

Adequate consumption of RS improves health, and, in particular, glycaemic control (ie: beneficial in pre-diabetes). For example, Patterson et al (2019) found that baked then chilled potatoes (high RS) reduced insulin in women compared to boiled potatoes (low RS). But this was a single food (Maiya et al 2022).

Maiya et al (2022) tested a full menu in their pilot study. A seven-day menu [16] was created and tested by fifteen US adults with pre-diabetes. Blood samples were taken and the participants rated the likeability of the foods.

Glucose in the blood decreased in the hour after eating, overall there was a small drop in body weight. This was a small pilot study, but it showed the potential of a high RS diet for individuals with pre-diabetes.

Table 6.1 summarises the key strengths and weaknesses of the study.

6.3. BEVERAGES AND TYPE 2 DIABETES

The risk of cardio-vascular disease (CVD) (as well as other problems), and premature death are increased for adults with type 2 diabetes. Dietary interventions can help with this condition, including beverage consumption.

Ma et al (2023) analysed data from the Nurses' Health Study (started in 1976) and Health Professionals Follow-Up Study (began in 1986) in the USA. Out of a

[16] Eg: breakfast - oats, corn flakes, tacos; lunch/snacks - soups, sandwiches and salads including potatoes, beans, pastas and bread.

STRENGTHS	WEAKNESSES
1. The creation of a varied diet for seven days which contained recommended macro-nutrients as well as high RS. Previous studies have tended to use RS supplements (Maiya et al 2022). 2. Self-reported adherence to the diet was high (around 80%). 3. Pre-diabetes status was based on standard measurements by healthcare providers (eg: fasting blood 100-125 mg/dL; oral glucose tolerance ≥140-<200 mg/dL). 4. Standardised methods of blood collection and analysis.	1. The RS content of individual foods vary based on plant breed, growing and storage conditions, preparation, storage, and consumption temperature. Thus it was difficult to establish exact RS content. 2. Participants were not in a controlled environment during the seven days, and may have eaten other foods. This information was not collected. 3. The sample was volunteers recruited using flyers, social media, and targeted emails in Houston, Texas. Eighteen adults enrolled, fifteen began the trial, but full data only on eleven (7 women; average age 40 years; average body mass index 32). 4. The sample was too small for statistical significance testing.

Table 6.1 - Key strengths and weaknesses of the pilot study by Maiya et al (2022).

total sample of over 170 000 adults in health care professions, over 15 000 had been diagnosed with type 2 diabetes. Average consumption of eight beverage groups was surveyed every 2-4 years - sugar sweetened beverages (SSBs) (eg: cola), artificially sweetened beverages (ASBs) (eg: low-calorie cola), fruit juice, coffee, tea, low fat milk, full fat milk, and water.

Among adults with type 2 diabetes, the highest risk of CVD, and death were associated with higher consumption of SSBs, and full fat milk, and lower risk with coffee, tea, water, and low fat milk.

Comparing consumption of beverages before and after diagnosis of type 2 diabetes, the following patterns emerged: "Broadly, increases in post-diagnosis consumption of coffee, tea, plain water, and low fat milk were associated with a reduction in mortality. Conversely, decreased consumption of fruit juice relative to pre-diagnosis levels was associated with a reduction in total mortality, CVD incidence, and CVD mortality, and decreased consumption of artificially sweetened beverages post-diagnosis was associated with reductions in CVD incidence and mortality" (Forouhi 2023 p1).

Evaluation of Ma et al (2023):

i) Large sample with long-term follow-up (average 18.5 years) (+). But predominantly White, US health professionals, which limits the generalisability of findings (-).

ii) Repeated measurement of diet and lifestyle factors, including before and after diabetes diagnosis (+).

iii) An observational study, which means that causation cannot be established because of "the possibility of residual confounding due to measurement errors of co-variates (including severity of diabetes, glucose control, and dietary and lifestyle factors) and unmeasured confounding (including genetic susceptibility and psycho-social stress) cannot be completely ruled out..." (Ma et al 2023 p11) (-).

iv) Beverage consumption frequency and quantity were self-reported, as were all diet and lifestyle measures, and the diagnosis of diabetes (-).

v) Key data were unavailable - eg: sugar added to coffee and tea; caffeinated and decaffeinated coffee not distinguished; smoothies, milkshakes, hot chocolate, yoghurt drinks, and non-dairy milk types not assessed. No distinction between participants was made based on severity or duration of diabetes symptoms, nor the use of drugs for the condition (Forouhi 2023) (-).

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7. FOOD SYSTEM RESILIENCE

"Food systems" include the production, processing, distribution, retail, preparation, and consumption of food. "These activities are undertaken by a wide range of people (actors) whose activities are influenced by a range of governance and social, policy, technological, market, environmental, and economic drivers, including stresses and shocks. The actors' activities result in a wide range of social, economic, and environmental outcomes" (Zurek et al 2022 pp513-514).

"Food system resilience" has become a key concern, particularly with the covid-19 pandemic. This involves changing food systems to be able to deal with "shocks, stresses, and risks" (Zurek et al 2022 p515) (eg: extreme weather events; geopolitical events; financial problems). The key changes relate to the provision of enough food, of good quality, at affordable prices, with meaningful livelihoods, and environmentally sustainable (Zurek et al 2022).

Holling (1973) provided a definition of resilience as "a measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Zurek et al 2022 p518). While Bene et al (2020) highlighted three key elements: the system's ability to "(a) to absorb losses due to disturbances, (b) to adapt through learning and incremental adjustments, or even (c) to transform through radical changes in the face of stresses and shocks" (Zurek et al 2022 p518). Another relevant concept is a "tipping point" (or threshold), "where a small perturbation triggers a large response" (Zurek et al 2022 p518).

Helfgott (2018) outlined four questions (known as the "four Qs") to help understand the resilience of a food system (Zurek et al 2022):

i) "Resilience of what?" - eg: soil; the crop; the local supply chain.

ii) "Resilience to what?" - the potential shocks, stresses and risks to prepare.

iii) "Resilience from whose perspective?" - eg: a farmer; a policymaker; a food distribution company.

iv) "For what time period do we need to build resilience?".

Tendall et al (2015) used the "three Rs" to build resilience - robustness ("system's ability to resist disruption to current outcomes"), recovery ("system's ability to return to current outcomes after disruption"), and reorientation ("system's ability to accept alternative system outcomes before or after disruption") (Zurek et al 2022 p521).

Zurek et al (2022) presented a case of a food system in the form of the UK, which prior to 2020 imported nearly half of the food consumed. In the last few years, shocks have included the change in relationships with the European Union, and the covid-19 pandemic. "A large proportion of fresh foods and meat are imported via the Dover Strait network. The business objective of maintaining low stock levels, especially for short shelf-life products, based on just-in-time supply chain strategies, relies on the Dover Strait and Channel Tunnel routes. Roll-On-Roll-Off ferry services between Dover and Calais and Dover and Dunkerque, and the Channel Tunnel's Freight Shuttle services between Folkestone and Calais, are the country's most significant arteries for the movement of food imports carried in accompanied road trailers. This therefore represents something close to a single point of failure in the UK food distribution network" (Zurek et al 2022 p516).

Changing food systems and creating resilience involves many actors/players to change, including "changing the policy, economic, social, and/or technological drivers that influence how different food systems actors undertake their respective activities" (Zurek et al 2022 p527).

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8. NUTRITION EDUCATION AND OBESITY PREVENTION (WITH PARTICULAR REFERENCE TO LOS ANGELES, CALIFORNIA)

Obesity prevalence in 2015-16 in the USA was 40% for adults, and 18.5% of children and adolescents, while the figures were 23.5% and 14% respectively in Los Angeles County, California (Kuo 2019).

"Because obesity's aetiology is multi-factorial, federal and state agencies, as well as community organisations and learning institutions, are beginning to tackle this problem by intervening on the underlying socio-ecologic factors that often fuel the development and exacerbation of this condition" (Kuo 2019 p1).

But poor nutrition and obesity can go hand in hand, particularly among disadvantaged groups in society. Thus, there is a need for interventions like nutrition education programmes (NEs), and policy, systems, and environmental change interventions (PSEs) (Sutton et al 2019b). Kuo (2019) observed rather depressingly: "The existing evidence base suggests that nutrition education alone is insufficient to change poor eating behaviours; that physical activity by itself is inadequate to reduce obesity; and that PSEs, while promising, are often symbolic, especially when they cannot be enforced, or when they are not embraced by the communities they intend to help" (p2).

In a survey of Los Angeles County, Sutton et al (2019b) found 70 NEs and 111 PSEs in 2014. The NEs offered group classes on nutrition and healthy eating, for example, while the PSEs included increasing access to healthy foods and beverages, and encouraging physical exercise/activity. The large number of programmes, in certain areas (like South Los Angeles), "may reflect the area's higher rates of poverty, food insecurity, obesity, and obesity-related chronic conditions, as compared to East Los Angeles and other areas of the county" (Sutton et al 2019b p5). Obesity was at 33% in household surveys of South Los Angeles, and only 10% overall consumed five or more servings of fruit and vegetables daily (Sutton et al 2019b).

Many of the NEs and PSEs had not been evaluated. Sutton et al (2019b) stated: "While it is known that individual behaviour change is difficult to achieve without addressing the environment in which people make decisions..., the evidence for many of the PSEs inventoried... is still only emerging – ie: the

body of work is at its infancy" (p6).

Involving supermarkets and grocery stores "represent an optimal setting for interventions that seek to improve food purchase decisions. Point-of-purchase (POP) interventions usually include the use of printed materials such as signs and labels, food demonstrations, and taste-testing to draw attention to healthier food products or options" (Sutton et al 2019a p1).

POP interventions are "viable in low-income communities" (p1), but are "only modestly effective in a few cases and are generally not uniformly impactful for increasing targeted food purchases" (Sutton et al 2019a p2).

Sutton et al (2019a) evaluated a POP programme in Los Angeles County. Six large retail grocery stores were studied between October 2014 and February 2015. "The programme used freezer clings, recipe cards, shelf wobblers, and floor stands as marketing materials throughout the store to promote healthy food purchases. Food demonstrations and test-tasting involving fruits and vegetables were also provided at the store to expose customers/patrons to unfamiliar produce and give them ideas on preparing these foods at home" (Sutton et al 2019a p2). Over 1000 shoppers were approached after leaving the store, and completed a survey.

After controlling for variables, "seeing at least one visual in the store and watching a cooking demonstration were not significantly associated with percent of total dollars spent on fruits and vegetables each week. Seeing at least one... [healthy eating] media advertisement in the community was not significantly associated with spending more on fruits and vegetables" (Sutton et al 2019a p3). Being female, and having higher educational qualifications were associated, however, with fruit and vegetable purchases. Spending on foods was self-reported.

Note that only one-quarter of participants reported seeing a relevant visual in store, and less than 10% overall watched a cooking demonstration (though such demonstrations were randomly performed across the study period).

Sadly, "changing shopping behaviour may be particularly difficult with low-income populations who often have restricted budgets" (Sutton et al 2019a p5). The researchers made a related observation: "Although grocery stores may offer a variety of fresh fruits and vegetables, they also are inundated with low-cost, unhealthy food options; thus, modest interventions may be

insufficient to improve health behaviours right away without complementary financial incentives..." (Sutton et al 2019a p5).

Another potential partner for PSEs is small neighbourhood stores, under the heading of "corner store conversions" (CSCs) or "healthy corner store programmes". "CSCs "typically involve an entity (eg: redevelopment agency or non-profit) partnering with small corner store owners to stock healthier foods (eg: fresh produce) in their stores, utilising in-store product placement or marketing to nudge patrons towards selecting healthier options" (Robles et al 2019b pp1-2).

Robles et al (2019b) assessed the "Small Corner Store Project" in Los Angeles County between 2013 and 2016, which involved thirteen stores in low-income neighbourhoods. Store owners and partnered organisation staff (key informants) were interviewed individually to understand their views on the project, while over 700 patrons were surveyed for their opinions.

The key informants described barriers like the practicalities of purchasing and transporting affordable fresh fruit and vegetables, and lack of support from store owners. Consumer demand for fresh food would make the supply of it attractive to the small store owners. Just over half of the patrons questioned bought fruit and vegetables at their local store, but nearly three-quarters purchased soda, sports drink, or other fruit drink there. The researchers concluded that "market factors such as higher pricing of healthier foods or a lack of demand for fresh produce represented additional barriers that were frequently difficult to mitigate. For instance, without favourable city policies that incentivise or subsidise the conversion process, many stores, even with good intentions, were unlikely to sustain their converted features over time, in fear of revenue losses. Similarly, without social norm change or a better understanding of what patrons expect from the corner stores they shop at, the business conditions that are needed to support higher sales volume of healthier food products were unlikely to emerge" (Robles et al 2019b p8).

There is also a paradox that fresh produce can be more expensive in poorer geographical areas than in affluent ones. Jewell et al (2019) confirmed such a case with data from Los Angeles County. It was found that prices in deprived areas surrounded by more affluent neighbourhoods were more expensive than in deprived areas surrounded by other deprived areas. It was nearly 50%

more for fresh produce, though prices did vary greatly between stores.

Areas/neighbourhoods were classified based on 50% or more of the population living at or below 185% of the federal poverty level (FPL). Twenty-one neighbourhoods and 108 stores were studied. Ten neighbourhoods (including 61 stores) were grouped as surrounded by similarly deprived areas, and eleven (including 47 stores) as surrounded by more affluent areas. The prices of fruit and vegetables were converted into dollars/cents per pound weight. The median price was $1.50 in affluent-surrounded areas compared to $1.05 in low-income-surrounded neighbourhoods.

Faith-based organisations (FBOs) have a role to play in implementing PSEs. Robles et al (2019a) assessed an example from the "Episcopal Diocese of Los Angeles", which operates over seventy food banks/food pantries, in 2016. Firstly, key informants were individually interviewed (eg: rector). A number of activities were mentioned, including a food policy (ie: healthy food served and distributed), encouraging church members to make healthier food selections, and education about nutrition, cooking, and physical exercise.

Next, 969 congregants were surveyed about health knowledge, behaviours and beliefs, and awareness of church programmes (table 8.1). Diocesan sites where projects were run had significantly more positive health behaviours and knowledge reported by the church members. The 45-65 years age group had the highest exposure to interventions. "While this suggests an important opportunity to influence the 46–65 group about healthy eating and physical activity, it also highlights the unintended disparities that exist for the other groups in terms of having differential access to interventions" (Robles et al 2019a p8).

Partnering with FBOs for PSEs has great potential: "In LAC [Los Angeles County] and elsewhere, FBOs often serve as a backbone for many marginalised communities and can more readily link together faith and health for their members. As such, they possess a unique capacity to widely and effectively reach high priority populations..." (Robles et al 2019a p9).

- Health beliefs: "My church has changed the way I think about food".
- Health behaviours: "I am more likely to choose water over soda today than six months ago".
- Health knowledge: "A way to prevent obesity is to eat smaller portions of food".
- Awareness of church programmes: "Do you know if your church holds food and nutrition classes?".

Table 8.1 - Examples of statements used by Robles et al (2019a).

Thompson et al (2019) proposed eight factors or domains by which to assess PSEs:

a) General thematic area - nutrition or physical exercise.

b) Specific strategy intervention - eg: healthy foods sold in local grocery stores.

c) Setting - eg: school; church; store.

d) Type of implementing organisation - eg: FBO.

e) Reach of implementing organisation - eg: small workplace; whole neighbourhood.

f) Level of PSE access - eg: change one company or whole neighbourhood environment.

g) Outcomes - eg: increased daily physical activity; increased purchase of fresh foods.

h) Opportunities to encourage change - eg; behaviour change in one or many areas of life.

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9. PROCESSED VEGAN FOOD

9.1. MEAT ALTERNATIVES

Prior to the 21st century, vegans were limited in the choice of foods available, but today there is an ever-increasing variety of products specially made, like meat alternatives. "While today's factory-produced foods make it easy to switch to a vegan diet without the need to make drastic changes to eating patterns, these alternatives might be worse for our health than the meat versions they are replacing" (Thomson 2021 p38).

There are three things to consider about these "fuss-free" vegan products (Thomson 2021):

i) The ingredients in them - Plant-based meat alternatives, for example, are processed foods, and so often contain additives to replicate the flavour or taste of meat, as well as high salt levels. In fact, some of these are ultra-processed foods (UPFs), which describes even more additives etc. "The 'health halo' typically associated with a vegan or plant-based diet no longer applies to individuals who follow these diets but include a high contribution of ultra-processed plant-based foods" (Thomson 2021 p40).

ii) The ingredients not in them - This refers to the essential nutrients that are typically obtained from meat, dairy and fish, and may not be in ready-made vegan products.

iii) What they are replacing - It depends on what food the individual has replaced with the vegan products.

Dietician Clare Thornton-Wood noted: "Today, being a vegan doesn't automatically mean you're eating a healthy diet" (quoted in Thomson 2021).

9.2. SOY PROTEIN

In 1999 the Food and Drug Administration (FDA) in

the USA agreed to the health claim that 25 g of soy protein per day reduced the risk of heart disease. It was based on the scientific agreement at the time (Petersen 2019).

But, initially since 2007, but more so since 2017, the FDA has been re-evaluating this claim. Studies on soy protein and coronary heart disease since 1999 have been "inconsistent and inconclusive" (Petersen 2019 p1).

Jenkins et al (2019) undertook a meta-analysis of forty-six intervention studies of high or moderate methodological quality on soy protein and cholesterol levels since 1999. Nineteen studies showed a reduced coronary heart disease risk, while the remainder did not (Petersen 2019).

Leaving aside the debate about soy protein and coronary heart disease, Petersen (2019) highlighted how the soy protein is consumed (ie: in protein snack bars, protein powders and other protein enriched foods). Put simply, in processed foods or UPFs. But soy-containing products have a "health halo effect" (Volkova and Ni Mhurchu 2015), meaning that the "negative" ingredients are overshadowed by the "healthiness" of the soy protein. "Thus, although soy products, such as unsweetened soy beverages, soy yogurts, tofu, and some fermented soy products, are part of healthy dietary patterns, consumption of ultra-processed products containing soy protein should not be encouraged" (Petersen 2019 p3).

Petersen (2019) also made this point: "Nutrition science is continually evolving, and it has become evident that reductionist policies that focus on single nutrients or components of whole foods may not completely align with the goal of chronic disease prevention. Whole food- and dietary pattern–based approaches are likely to have greater public health impact" (p3).

UPFs are positively association with overweight, obesity, and metabolic syndrome (eg: Juul et al 2018), and cardiovascular risks (eg: Rico-Campa et al 2019). Hall et al (2019), for example, found that 500 kcal per day more was consumed on an ultra-processed diet compared to an unprocessed diet in a controlled study.

Rico-Campa et al (2019), a Spanish study, showed that four servings or more per day of UPF increased the risk of early mortality by 62%. In a French study (using the NutriNet-Sante cohort; appendix 9A) (Srour et al 2019), the highest quartile of UPF intake individuals had a 13% increase in coronary heart disease compared to the lowest quartile (Petersen 2019) (appendix 9B).

9.3. APPENDIX 9A - NUTRINET-SANTE COHORT

The NutriNet-Sante cohort study was started in 2009 in France with more than 160 000 adults. Every six months the participants complete a three-day dietary record. Gehring et al (2021) used the 2016 data to compare a sub-sample of the cohort (n = 21 212), divided into meat-eaters (n = 19 812), pesco-vegetarians ("fish-eating vegetarians") (n = 646), vegetarians (n = 500), and vegans (n = 254), in terms of UPFs eaten and nutritional quality of diets.

An UPF was defined as "using industrial processes such as hydrogenation, hydrolysis, extruding, moulding, reshaping, and pre-processing by frying. It also includes foods with added chemicals and substances such as flavouring agents, colouring, emulsifiers, humectants, non-sugar sweeteners, and other cosmetic additives" (Gehring et al 2021 p122). The group includes "vegetable patties (industrial plant-based meat substitutes) containing food additives and also mass-produced packaged breads and buns, sweet or savoury packaged snacks, industrialised confectionery and desserts, sodas and sweetened beverages, meatballs, poultry and fish nuggets and other reconstituted meat products processed with the addition of preservatives other than salt (eg: nitrites), instant noodles and soups, frozen or shelf-stable ready meals, and other food products made mostly or entirely from sugar, oils, and fats and other substances not commonly used in culinary preparations such as hydrogenated oils, modified starches, and protein isolates" (Gehring et al 2021 p122).

Each participant was given an "UPF score" based on the proportion of energy from UPFs in the diet.

The proportion of energy from UPFs was significantly higher among vegetarians and vegans as compared to meat-eaters. "The higher intake of UPFs by vegetarians and vegans was driven by a higher consumption of plant-based meat and dairy substitutes" (Gehring et al 2021 p125). But while vegetarian and vegan groups included "the highest proportions of individuals favouring healthy plant-based foods, they also had the highest frequency of individuals favouring unhealthy plant-based foods" (Gehring et al 2021 p125).

Duration of vegetarian or vegan diet was an important variable. "Persons who had started a vegetarian or vegan diet more recently were more likely to eat more UPFs than those who started longer ago. This may be explained by the fact that vegetarian diets seem to include healthier plant-based food over time. Increased

knowledge of nutrition and how to balance a vegetarian diet over time may lead to a gradual replacement of UPFs by unprocessed foods" (Gehring et al 2021 p128).

The overall cohort was volunteers, and the sub-sample in this study involved those who had completed an extra online questionnaire entitled "Food Avoidances" in 2016. "There was a probable selection bias because willing participants could have been more health-conscious. Some differences between the included and excluded participants were observed, indicating another potential selection bias. In addition, the population was not representative of the entire French population in terms of socio-demographic characteristics (high proportion of women and retired persons). Caution is therefore needed in generalising these results to the overall French population" (Gehring et al 2021 pp128-129).

The diet status of individuals was based on self-identity and data from dietary records. These records were comprehensive for a 24-hour period, accepting the accuracy of self reports.

The calculation of proportion of energy from UPFs was an estimate from dietary data. Also the nature of UPFs was an approximation, as the researchers accepted that "food processing is complex. While ensuring micro-biological safety and preservation, it alters the food matrix and may form new compounds... [and] processed foods can also be characterised by the addition of fat, sugar, and/or sodium, as well as the presence of food additives" (Gehring et al 2021 p129).

Gehring et al's (2021) study was cross-sectional (ie: "one shot in time"). The researchers explained: "The individual characteristics and motives influencing the contribution of UPFs in vegetarian populations... needs further study. Longitudinal studies will be necessary to evaluate the health consequences of UPFs, especially because of the growth in the number of vegetarians, including young vegetarians, and the growth of the plant-based processed foods market" (Gehring et al 2021 p129).

9.4. APPENDIX 9B - TRANS FAT

Many processed and ultra-processed foods include "industrially produced trans fatty acids" (ITFA), and this has been linked to increased risk of coronary heart disease (CHD) morbidity and mortality. "The detrimental health effects of ITFA have been increasingly recognised

since the early 1990s. ITFA substantially increase CHD risk by raising LDL-cholesterol, reducing HDL cholesterol, promoting systemic inflammation and impairing endothelial cell function. On a per-calorie basis, ITFA increase CHD risk more than any other type of fat: every 1% increase in daily energy obtained from ITFA raises CHD mortality by approximately 12%" (Bjoernsbo et al 2022 p2).

Food containing ITFA tends to be cheaper, and so is consumed relatively more by poorer individuals.

Certain countries have introduced a ban on ITFA, like Denmark, which did so in 2004. Restrepo et al (2016) calculated that 7000 deaths had been prevented annually by the ban.

Bjoernsbo et al (2022) further qualified the benefits of the ban using various data sources including seven-day food diaries for Dan-MONICA III (multi-national MONItoring of trends and determinants of CArdio-vascular disease) (663 men and women in 1991) and DANSDA (Danish National Surveys of Dietary Habits and Physical Activity) (2792 participants in 2005-8). The ITFA content in food was estimated, and converted into percentage of total daily energy intake (%E). The reduction in CHD deaths for a given reduction in ITFA came from a meta-analysis by Mozaffarian et al (2006).

Overall, mean energy intake from ITFA fell from 1% in 1991 to 0.1% in 2007. It was estimated that there were 1191 fewer CHD deaths as a consequence in this period, and the greatest benefit was seen in the most deprived quintile.

The ITFA ban was attributed to reducing the total CHD deaths by 11%, taking into account other health measures (eg: reduced smoking and weight; cholesterol-lowering drugs). This attribution was 27% for the most deprived quintile.

Ideally, there would be a control or comparison group where the ITFA ban had not occurred. This could be another time period in Denmark, or the same time period in another country, if such comparisons are possible.

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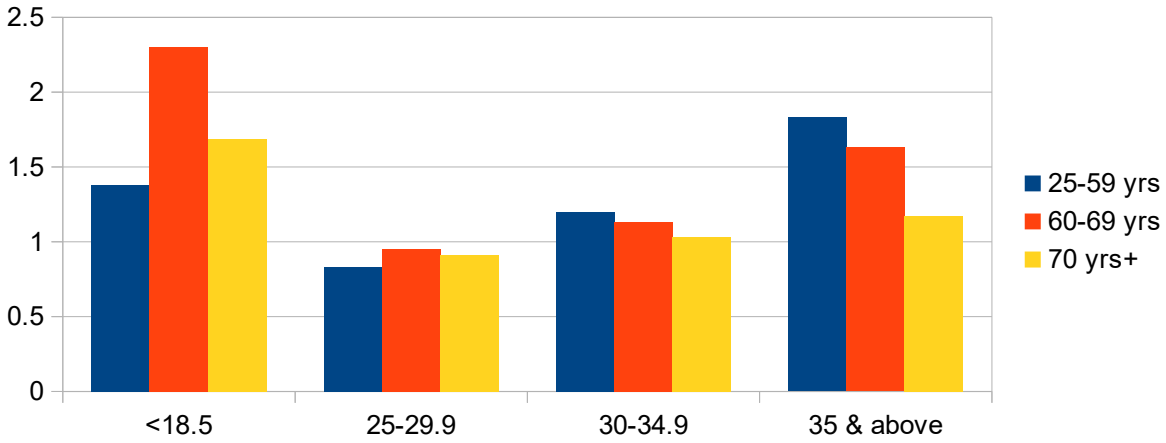
10. FOOD AND DEATH

10.1. BODY MASS INDEX AND MORTALITY RISK

The body mass index (BMI) (weight in kg divided by height in metres squared) of 25 is used as the cut-off for overweight. "It is unclear exactly where this figure stems from, but it seems to have been cemented into the medical orthodoxy by a report from a meeting of the World Health Organisation in 1997" (Wilson 2022 p28).

But the relationship between earlier death and higher BMI is not definitive in the 25-29.9 BMI range. In fact, individuals in this range have a lower death rate than in the "normal" BMI range (18.5 - 24.9) (Wilson 2022).

Studies suggest that the relationship between BMI and mortality is U-shaped - ie: significantly higher for underweight (BMI >18.5) and obesity (BMI ≥30) as compared to the normal weight, but not for overweight. Flegal et al (2005), for example, showed this relationship with data from the USA - the National Health and Nutrition Examination Surveys (NHANES) I (1971-1975), II (1976-1980) and III (1988-1996) (figure 10.1).



(Data from table 2 p1864 Flegal et al 2005)

Figure 10.1 - Relative risk of death based on BMI and age (where normal weight = 1.00).

Flegal et al (2013) performed a meta-analysis based on the motivation that prior studies had not addressed BMI systematically (ie: "used a wide variety of BMI categories and varying reference categories, which can make findings appear more variable than when standard categories are used and also can make it difficult to compare and synthesise studies"; p71). These researchers found 97 relevant studies on BMI and mortality. Compared to the normal weight range, risk of all-cause mortality was slightly reduced for overweight, but increased for obesity.

There were differences between the included studies in terms of methodology, including:

i) Self-reported or measured height and weight to calculate BMI. However, this did not change the overall pattern of findings.

ii) BMI category range for "normal weight" - eg: 18.5 - 24.9 or 20 - 24.9.

iii) Control of confounders (eg: smoking; health conditions).

iv) The majority of studies came from North America and Europe (n = 78).

v) Some studies covered all BMI ranges, while others focused on specific groups (eg: obesity).

10.2. LONGEVITY DIET

The term "longevity diet" has emerged from animal research, though the research can be conflicting (The leader 2022). This is the idea that certain foods could "actually slow down the ageing process" (Lawton 2022 p39).

The optimal diet contains more wholegrains, fruits, vegetables, nuts, legumes, and fish, and less meat, dairy, refined grains, and sugars than the typical Western diet. It has been calculated that switching to such a diet at age 20 years in the West would extend the average lifespan of a woman by ten-eleven years and a man by 13 years (Fadnes et al 2022).

Another area of interest with food and ageing is "calorie restriction" (CR), defined as "lessening caloric intake without depriving essential nutrients" (Waziry et

al 2023 p248). This has been studied in the "Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy" (CALERIE) Trial in the USA. Over two years, 220 healthy 21-50 year-olds were randomised to 25% CR or usual diet (Waziry et al 2023).

Three measures of biological ageing were assessed by Waziry et al (2023):

i) Dunedin-PACE (Pace of Ageing Computed from the Epigenome)(Belsky et al 2022) - "Pace-of-ageing" over time in nineteen blood chemistry and organ function test metrics. "Pace-of-ageing measures estimate the rate of biological ageing, defined as the rate of decline in overall system integrity. Pace-of-ageing values correspond to the years of biological ageing experienced during a single calendar year. A value of 1 represents the typical pace of ageing in a reference population; values above 1 indicate faster pace of ageing; values below 1 indicate slower pace of ageing" (Waziry et al 2023 p250). Reference data came from the "Dunedin Study".

CR slowed the pace-of-ageing significantly according to this measure.

ii) PhenoAge DNAm clock (Levine et al 2018)- Analysis of nine blood markers, and CR had no impact here.

"DNAm clock measures of ageing are algorithms that estimate biological age, the state of an organism's biology represented as the age at which that state would be typical in a reference population" (Waziry et al 2023 p250). The reference population data came from the "US National Health and Nutrition Examination Surveys", the "Invecchaire in Chianti (InCHIANTI) Study", and the "US Health and Retirement Study".

iii) GrimAge DNAm clock (Lu et al 2019) - Analysis of eight protein markers compared to data from the "Framingham Heart Study Offspring and Gen3 Cohort". No impact of CR here.

The three measures are statistical models to predict future risks and outcomes. Waziry et al (2023) commented: "Follow-up in the CALERIE Trial did not extend beyond the intervention. It is therefore unclear if the changes in DunedinPACE observed during the 2-yr intervention will translate into reduced morbidity and mortality over the long term. In observational studies with long-term follow-up, individuals with slower DunedinPACE are better-off on a range of healthspan metrics, including

showing reduced incidence of morbidity and increased survival. These previous studies suggest that the CALERIE treatment effect of 2–3% slower pace of ageing corresponds to a reduction in mortality risk of as much as 10–15%, similar in magnitude to the effect of smoking cessation intervention" (pp250-251).

There is "no gold standard measure of biological ageing" (Waziry et al 2023 p252), and there are issues of validity and reliability with any measure used.

The CALERIE Trial sample was not representative of the general population (ie: healthier). "On average, trial participants did not achieve the prescribed dose of 25% CR and some control group participants reduced their caloric intake. Despite this imperfect adherence, treatment group participants experienced substantial and sustained weight loss and related changes in body and tissue composition, broad improvement in cardio-metabolic health and a slowing of ageing-related physiological changes" (Waziry et al 2023 p252).

In summary: "Treatment effect sizes were small. Nevertheless, modest slowing of the pace of ageing can have profound effects on population health" (Waziry et al 2023 p248).

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11. LIFE BY TWO NUMBERS

Many health messages have become simplified into numerical values to live by (eg: drink eight glasses of water per day; brush teeth for two minutes, twice each day); what Tait (2022) called "recommended dailies".

Here are two of them (Tait 2022):

1. 10 000 steps of exercise per day.

This exact figure probably originated from a marketing campaign in Japan in the 1960s (Tait 2022), but more exercise is better than less, up to a point.

Ekelund et al (2019) performed a meta-analysis on eight studies using accelerometry-measured physical activity, and all cause mortality. Overall, any level of physical activity was associated with reduced risk of mortality, and less time spent sedentary was also important. A maximum risk reduction of premature death was calculated at about 375 minutes of light intensity physical activity per day or 24 minutes of moderate-to-vigorous physical activity. On the other side, 9.5 hours or more per day spent sedentary was associated with a statistically significant higher risk of death. As with any meta-analysis, the studies included varied in terms of methodology (table 11.1).

- Age of participants (mean 63 years)
- Length of follow-up (mean six years)
- Sample make-up (three-quarters female overall)
- Accelerometry device used, and length of wearing
- Location of study (USA and Western Europe only)
- Physical activity variables (eg: total; intensity)

Table 11.1 - Some methodological variables in the studies in the meta-analysis by Ekelund et al (2019).

Wearable devices can provide information on physical activity energy expended (PAEE), and intensity of activity. But are the health benefits from the volume of PAEE or the intensity?

Strain et al (2020) analysed data from a sub-sample of over 96 000 UK Biobank participants (middle-aged adults). Participants wore a wrist-worn accelerometer for seven consecutive days on their dominant wrist. The time spent in light, moderate, and vigorous physical activity was converted to PAEE in kJ/kg/day (table 10.2).

Higher PAEE was associated with less risk of all-cause mortality over follow-up of three years on average, and achieving the PAEE via higher intensity physical activity was better than light intensity. So, the risk of mortality was reduced by moderate intensity physical activity above the benefits of PAEE.

This study used standardised methods for calculating energy expended, from a prospective study with a large sample. But the study could not establish causality. The UK Biobank sample has been shown to be healthier, and more affluent than the British general population (Strain et al 2020).

- Walking is classed as a moderate intensity physical activity, but gait speed is important. A standard test of this is walking four metres distance in sex seconds, while another is a six-minute walk test. Both tests have been found to associate with heart mortality (Zhou et al 2022).
- Such controlled tests measure "quality" (intensity) not "quantity" (duration) of physical activity (Zhou et al 2022).
- Other primary measures of physical activity are self-reports, and activity monitors worn on the body, or, more recently, in smartphones carried by individuals (Zhou et al 2022).

Table 10.2 - Walking.

2. Five portions of fruit and vegetables a day.

The World Health Organisation recommended a daily minimum of 400 g of fruit and vegetables per day, and the division of this figure into five portions was based on the average weight of a small orange, for example (Tait 2022) [17].

Any fruit and vegetables consumed is better than none, but ten portions or 800 g each day may be better than five portions. The dose-response relationship is the technical way of describing the recommended daily intake, and large epidemiological datasets allow this process. in the case of fruit and vegetables, intake has been studied in relation to cardiovascular disease, cancer, and death, for instance.

Aune et al (2017) investigated optimal intake with a meta-analysis of 95 studies. Only prospective studies published up to mid-2016 were included. Relative risk of

[17] The figure varies around the world - eg: 500 g in Sweden, 600 g in Norway, and up to 800 g per day in the USA (Aune et al 2017).

cardiovascular diseases, cancers, and all-cause mortality were calculated for different fruit and vegetable intakes per day. It was found that "reductions in risk of cardiovascular disease and all-cause mortality were observed up to an intake of 800 g/day of fruit and vegetables combined, whereas for total cancer no further reductions in risk were observed above 600 g/day" (Aune et al 2017 p1030). Relative risk of the three outcomes were reduced by around 10% for every 200 g per day increase in fruit and vegetable intake (to a point).

More specifically, as the researchers explained, "several individual types of fruits and vegetables were inversely associated with coronary heart disease, stroke or cardiovascular disease (apples/pears, citrus fruits, cruciferous vegetables [eg: broccoli], green leafy vegetables, tomatoes and beta-carotene-rich and vitamin C-rich fruit and vegetables), total cancer (cruciferous vegetables and green-yellow vegetables [eg:celery]) and all-cause mortality (apples/pears, berries, citrus fruits, cooked vegetables, cruciferous vegetables, potatoes, and green leafy vegetables/salads). In contrast, intake of tinned fruits was associated with increased risk of cardiovascular disease and all-cause mortality" (Aune et al 2017 p1047). The latter point depended on a small number of studies though.

"Combining studies from different populations increases the sample size and statistical power, but also results in heterogeneity because of differences in the characteristics of the study populations" (Aune et al 2017 p1048). In any meta-analysis the studies included will vary in methodology, which in this case included differences in samples, duration of follow-up, dietary assessment and measurement of fruit and vegetable intake, and outcome measures. "There are also likely to be large differences between populations in the types, amounts and preparation methods of fruits and vegetables consumed, as well as differences in the stability of the intakes over time and differences in the incidence of specific cancers and specific causes of death that contribute to total cancer and all-cause mortality" (Aune et al 2017 p1048).

Confounding variables and their control is another issue. Aune et al (2017) explained: "Fruit and vegetable intake is often associated with other lifestyle factors such as lower prevalence of smoking, less overweight and obesity, higher physical activity and lower intakes of alcohol and red and processed meat, which could have confounded the observed associations. Many studies adjusted for these and other confounding factors, and we found little evidence that the results varied

substantially whether or not adjustment for most of these confounders was done. It is possible that persons with a high fruit and vegetable intake may be more likely to undergo screening or have better access to or compliance with treatment, and this could lead to an improved survival and bias the results for mortality" (p1048).

Data were limited or lacking from Africa, West Asia, South and Latin America. Some of the studies in North America, for example, did include different ethnic groups.

In terms of the strengths of this meta-analysis, three in particular stand out:

i) A wide number of search terms were used in the literature search.

ii) A large number of cases and deaths in total (eg: 112 000 cancer cases).

iii) The high methodological quality of the included studies.

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12. CHEWING

Survival is based on energy input (food acquired, processed and consumed) and expenditure (involved in acquisition and processing), but also consumption (ie: the cost of chewing or mastication in animals that do so, like mammals). "An essential outcome of mastication is the comminution of a food into small particles, lubricating them with saliva, so promoting the formation of a bolus (a ball of particles bound together by saliva) that can be swallowed easily and then digested. Teeth break foods down mechanically in the oral cavity via the initiation and propagation of fractures that are often resisted by the internal mechanical properties of these foods. The energy needed to reduce food particles from their ingested size down to what is swallowed defines the efficiency of the process" (van Casteren et al 2022 p1).

van Casteren et al (2022) attempted to estimate the metabolic cost of chewing in humans in a study with twenty-one volunteers. Participants were asked to chew two different commercially-available gums that varied in stiffness for fifteen minutes each. Metabolic measurements were made using indirect calorimetry (ie: oxygen consumption and carbon dioxide production inside a whole-head Perspex hood).

Energy expenditure increased by 10-15% above baseline resting measures during the chewing of the gum, with more energy used for the stiffer gum.

Considering these findings in terms of human evolution, van Casteren et al (2022) suggested that "before the onset of cooking and sophisticated extra-oral processing, the mastication of food could have required a much larger proportion of a daily energy budget" (p4). So, there would be selection pressure for energy optimisation in mastication. "This optimisation is likely to manifest in two main ways: Either the musculo-skeletal system used for chewing can be optimized for efficient use, and/or tooth morphology can be optimised for increased effectiveness in the breakdown of foods" (van Casteren et al 2022 p5).

But early humans adopted cooking of food, particularly meat. This influenced the chewing process in the sense of making it easier. Extrapolating from their data, van Casteren et al (2022) speculated that hominins not cooking meat would use more energy chewing than gained from raw meat.

This type of research fits with the "evo-devo approach". "Evo-devo" studies have emerged in recent

years "combining genetics and development with evolution" (Fostowicz-Frelik and Tseng 2023 p1). For example, the anatomy of the mammalian skull can be studied with X-ray imaging, combined with data from the fossil record.

In fact, Fostowicz-Frelik and Tseng (2023) described the combination of three areas of study (in relation to the skull):

- Development
- Structure and fossil record
- Function and mechanisms

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13. SENSING HEALTHY FOOD

"Healthy food" can be defined as that "high in nutrients and low in calories/fat/sugar" (Motoki and Togawa 2023 p1). Motoki and Togawa (2023) reviewed the recent research on decisions to purchase/consume healthy food and the senses.

1. Vision

i) Colour - This includes the purchasing environment, as well as the food itself.

a) Purchase environment - Findings include that a healthy snack is chosen more often in a brightly than dimly lit room, while black-and-white colours in advertising images influences attitudes towards healthy preferences. The green colour on packaging in the "traffic-light system" for rating food encourages purchase of low sugar products (compared to no colour).

b) Food - eg: colourful salads are preferred to pale ones.

ii) Shape - For example, it was found that "angular shapes were more associated with healthy food, whereas round shapes were more linked to unhealthy food. Moreover, consumers tended to prefer healthy foods with angular shapes (ie: angular wholegrain bread) compared with healthy foods with round shapes (ie: circular wholegrain bread)" (Motoki and Togawa 2023 p2). But not all studies agreed.

In terms of packaging, that "mimicking a slim humanoid was perceived as healthier than packaging resembling a less-slim humanoid. Moreover, the effects of package slimness were more pronounced in women and those with higher body mass index" (Motoki and Togawa 2023 p2).

iii) Position of images - Placing a picture of the food on the packaging at the bottom as compared to the top, for instance, led to the food being perceived as richer, and less was ate. Togawa et al (2019) showed this in a series of experiments with Japanese undergraduates and fictitious foods like popcorns and cookies.

The view of the food on the packaging (ie: looking up or down on it) has been studied, but with mixed results. For example, a food product was perceived as healthier if looking up at it, but consumption was not influenced. Looking up at a food item has also been found

to associate with perceived sweetness.

In a series of experiments (eg: Manippa et al 2020), it was found that the position of a "Healthy" or "Low Calorie" label on the left or right of the packaging matter - left side perceived as healthier.

iv) Aesthetics - eg: artistic appearance of the food and the willingness to pay more for salads.

2. Sound

i) Background music/noise - eg: playing music with a higher pitch, and a lower volume increases the choice and sale of healthy food.

Specific to the type of music, classical and jazz music increased the preference for healthy foods compared to rock or heavy-metal music playing (Motoki et al 2022). Playing soft-nature sounds has the same effect.

ii) "Sound branding" - This is the sound of the brain name or sonic logo. For example, Motoki et al (2021) found that "higher-frequency sounds (i, e, f, s) in fictitious brand names were rated as more appropriate for healthy food names than lower-frequency sounds (b, d, g, u, o) in fictitious brand names. This suggests that sounds in brand names might influence preferences for healthy foods" (Motoki and Togawa 2023 p4).

3. Smell - For example, ambient odours and congruent food (ie: similar types of food to the odour in the air) may influence decisions (eg: fruit odours and selection of fruits and vegetables), though there is contradictory evidence. "Recent research has revealed that the exposure time to odours modulates how odours influence healthy food preferences. Specifically, people were more likely to choose healthy foods when exposed to an ambient scent of indulgent versus non-indulgent foods (ie: chocolate-chip cookies vs strawberries) for a long time (more than two minutes)" (Motoki and Togawa 2023 p4).

4. Touch - Attributes here include temperature, weight, and texture. For example, warm foods are perceived as having more calories than cold foods. Meanwhile, physically lighter food is regarded as healthier (ie: having less calories).

van Rompay et al (2020) performed an experiment

manipulating the texture of "food" (3D-printed modals) (smooth, rough, rough or irregular) and salt content (low, medium, and high). "In medium- and high-salt conditions, a smooth texture resulted in a lower willingness to try than a rough or irregular texture. Conversely, in the low-salt condition, a smooth texture led to a higher willingness to try than a rough or irregular texture" (Motoki and Togawa 2023 p4).

5. Multiple senses - Multi-sensory virtual environments have been tested (eg: sunny-day picnic; sudden rain-shower picnic; peaceful nature scene). For example, a preference for a healthy snack over an unhealthy one in a peaceful nature virtual environment compared to a blank scene (Pennanen et al 2020).

Multi-sensory exposure (eg: smell and visual) has been found to be better for pre-school children and vegetable acceptance than single sensory exposure (eg: vision) (Roberts et al 2022).

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14. MISCELLANEOUS

14.1. SUNLIGHT

Men may eat more in the summer than women. Sunlight on the skin causes the release of an appetite-stimulating hormone, and this was first noticed in mice in laboratory experiments using ultra-violet light (Wilson 2022).

This observation was subsequently tested with 3000 adults in Israel (Parikh et al 2022). Based on three years of questionnaire data, it was found that men consumed 17% more calories per day between March and September as compared to the other months, while women were consistent throughout the whole year.

It seems that the appetite-stimulating hormone (probably ghrelin) which is stimulated by sunlight is blocked by the release of oestrogen in women (Wilson 2022).

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14.2. ALCOHOL CONSUMPTION AND PRACTICE

An interesting question is why unhealthy behaviours persist when there is clear advice about them. "Practice theories" in sociology (eg: Shove et al 2012) attempt to explain why such behaviours (or practices) continue even when individuals are aware of the health risks. For example, "specific practices are made up of a recognisable relationship, configuration, and combination of interconnecting elements – materials (objects and technologies), meanings (engagements and emotions), and competences (practical understandings, embodied knowledge, and the physical dispositions and cognitive processes) – which become deeply embedded as routines and habits, as routinised ways of engaging and relating to the social world" (Hennell et al 2023 p357).

Gender is also important, and this can be applied to the practice of drinking alcohol and getting drunk in social settings.

Hennell et al (2023) gathered data from twenty-three 16-21 year-olds in Northwest England in 2015-16 about their alcohol consumption practices. The study showed that "participants engaged in various and different drinking practices, such as alcohol consumption with family, or friends, or with a meal. However, for all the study participants and on several occasions, they engaged in one particular intoxicated drinking practice, which was constituted by a bundle of practices that came together to form a drinking occasion framed as a 'proper night out'. The bundle arrangement consisted of six (inter) connected practices: 'planning', 'getting ready', 'pre-drinking', 'going out', 'getting home', and 'storytelling' (Hennell et al 2020)" (Hennell et al 2023 p360).

Hennell et al (2023) focused on three themes related to gender:

i) "The corporeal and 'getting the right look'" - A lot of effort went into the "right" look, "a hyper-feminity, a type of 'over the top' femininity" (Hennell et al 2023 p360), as "Charlotte" explained: "If we are going into town, it would be like heels, full face of make-up, dress and hair completely like curled - everything" (p360). Social media allowed the sharing of images and commenting, so that the whole group "co-ordinated". Men were "well-groomed", but in a less co-ordinated way.

ii) "The embodied experience of intoxication: alcohol and 'drinking the right drink'" - Intoxication was the goal of the "proper night out", and though the participants talked of "any alcohol will do", there were gendered practices observed. "The young women in the study expressed a preference for wine, cocktails, and alcopops, feminising the drinking experience. In contrast the young men in the study expressed a preference for beer and whisky, demonstrating and endorsing elements of hegemonic masculinity" (Hennell et al 2023 p362).

The experience of intoxication also followed a gendered narrative. "Phoebe", for example, talked of being "tipsy" as desirable (ie: a "controlled loss of control"; Measham and Brain 2005), though the alcohol she consumed was higher than that. "In her storytelling, Phoebe is rehearsing a respectable femininity that distances her intoxicated self from the working-class

binge drinker depicted in popular discourses... The unacceptable performance of femininity relating to uncontrolled intoxication is conflated by the young women with a particular image of womanhood which was considered unacceptable" (Hennell et al 2023 p364).

Meanwhile, "the young men enacted an embodied performance of masculinity through their intoxicated loss of bodily control" (Hennell et al 2023 p365).

iii) Caring - This behaviour "was associated with looking after and supporting friends suffering from the ill-effects of intoxication during the practice, helping each other to get home, physical protection, and supporting each other through any other drink-related accidents linked to the practice. Amy, for example, explained how she regarded herself as the 'sensible one' who drinks less and is able to look after her friends" (Hennell et al 2023 p365).

Hennell et al (2023) ended: "The performances of the practice for both the young men and young women are judged and are seen as being valued and accepted or not, by themselves, by their friends, by other participants of the practice, and by their wider social networks" (p368).

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15. FOOD REWARD SYSTEMS

15.1. PHYSIOLOGY

In an environment historically with limited food, humans evolved "heightened motivation to obtain energy-dense food" (Hanssen et al 2023 p1). But in today's food-dense environment, such behaviour can explain obesity. In terms of the motivation, dopamine (DA) as an internal reward is key - ie: "our brain is wired to want food and experience pleasure (reward) from eating" (Hanssen et al 2023 p1).

The idea of "diet-induced obesity" (DiFeliceantonio and Small 2018) suggests that "repeated stimulation of reward circuitries by palatable food leads to neurobiological adaptations that in turn promote excess food intake and body-weight gain" (Hanssen et al 2023 p3). This has been shown in rodent studies where the type of diet and amount of food available can be controlled. For example, a high-fat diet changes the DA available in the brain, with the upshot of compulsive eating and weight gain, as individuals also have increased reactivity to food cues (eg: a picture of a burger; appendix 15A). Changes take place in hormones like leptin and insulin with obesity also (Hanssen et al 2023).

Hanssen et al (2023) stated: "Rodent and human studies in the last decades have fundamentally changed our perspective on food-seeking behaviour and its alteration in obesity. Food selection is no more regarded as a purely conscious process. Food-reward behaviour is driven by a strong interplay between the brain and the periphery that is mediated by neuronal and hormonal pathways. The DA system has been identified as a key player in encoding food reward — highly interacting with homeostatic pathways and higher cognitive circuits. Ultra-processed high-fat/high-sugar diet has a crucial impact on several aspects of this well-orchestrated system driving overeating and weight gain" (p5).

"Wanting" and "liking" are two components of food reward, defined by Baugh et al (2023) thus: "'liking' describes the hedonic impact of a reward, and 'wanting' refers to incentive salience, or cue-triggered

motivation" (p1).

In terms of liking and brain physiology, "a particular portion of nucleus accumbens, a 'liking hotspot' [Pecina and Berridge 1995]" (Baugh et al 2023 p1) has been pinpointed in rodent studies. This brain area is also involved in wanting, but a different pattern of neural activity. In rodent studies it is possible to separate liking and wanting in terms of physiology, but this is more difficult in research with humans (Baugh et al 2023).

15.2. INTERVENTIONS

Tzavella et al (2023) observed: "If we assume that an overvaluation of intrinsically rewarding foods is a key determinant of eating behaviours, then we can further posit that reducing the affective value of specific foods using psychological interventions should have a therapeutic potential" (p1).

In laboratory experiments, "food valuation" has been measured by explicit and implicit methods. The former involves asking participants to rate the attractiveness (value) of a certain food using the Likert Scale, for instance. This method "could potentially be affected by the same limitations as any other self-report measures, such as demand characteristics and strategic response bias, but this should hold true for any assessment that can make participants aware of the study aims..." (Tzavella et al 2023 pp2;4). Implicit measures test the speed of response to particular stimuli and associations. For example, the reaction time to the word "chocolate" and the word "pleasant" compared to the words "chocolate" and "unpleasant". "A key assumption of implicit measures is that they can tap into participants' automatic affective evaluations because tasks have strict time constraints that reduce the likelihood of controlled/conscious processing" (Tzavella et al 2023 p4).

Stice et al (2022b) dismissed behaviour-based weight-loss programmes as they "almost never produce lasting weight loss" (p1), and argued for a strategy of inhibition and attention training for high-calorie foods. This approach is based on the assumption that "obesity results from elevated reward and attention brain-region response to high-calorie foods and their cues coupled with lower recruitment of inhibitory regions that modulate food reward and attention responsivity" (Stice

et al 2022b p1).

Studies have shown greater activity in brain regions related to reward processing (eg: striatum) in response to high-calorie food images among individuals who gain weight, along with attentional bias to such images, and lower activity in inhibition-control regions of the brain (eg: inferior frontal gyri) (Stice et al 2022b).

Inhibition training includes the Go/NoGo (GNG) paradigm, where individuals must response as quickly as possible to an image, in this case low-calorie foods (Go), and not respond to images of high-calorie foods (NoGo). While attentional training involves focus on a visual search task, say, while ignoring images where there is attentional bias (eg: high-calorie foods).

Stice et al (2022b) reported their work on a combined approach (inhibition-control and attentional training). In a pilot study (Stice et al 2017), participants were trained in four weekly 50-minute sessions to direct attention towards images of low-calorie food, and to inhibit responses to images of high-calorie food. The foods were personalised for the individual, making this an example of a "personalised precision-medicine intervention" (Stice et al 2022b p2). "Overweight or obese adults who completed the intervention showed greater body-fat loss from pre-test to post-test than controls who completed placebo training. Intervention versus control participants also showed greater reductions in brain reward (putamen, mid-insula) and attention- (inferior parietal lobe) region response to, and palatability ratings and monetary valuation of, high-calorie foods, consistent with the thesis that training reduces valuation of high-calorie foods" (Stice et al 2022b p2) [18]. A follow-up trial (Stice et al 2018) with six weekly 20-minute training sessions was similarly successful (Stice et al 2022b).

Both these trials were relatively small-scale (eg: 47 participants; Stice et al 2017), so Stice et al's (2022a) study included 179 overweight/obese adults, and four weekly sessions. "Participants randomised to the intervention showed significantly greater increases in palatability ratings of low-calorie foods compared with placebo controls. However, participants who completed the intervention did not show body-fat loss, reductions in palatability ratings and monetary valuation, or brain reward and attention-region response to high-calorie foods compared with placebo controls" (Stice et al 2022b p3).

[18] This could be described as the "no-go devaluation effect" (Tzavella et al 2023).

The researchers explained these lack of differences as due to participants not forming an inhibition response for high calorie foods during training. Also different food images were used in the training here. Stice et al (2022b) explained: "In the earlier trials, we included only images of fruits and vegetables in the low-calorie (go/attend) category and fewer categories of unhealthy food images. In the current trial, we included other types of low-calorie foods taken from ten different categories, including whole-grain foods, sushi, eggs, fish, and lean meats. The high-calorie foods also encompassed a more diverse range of 10 sub-categories, including sweet foods, pizza, meats, fast food, and drinks. It is possible that the boundaries may have been 'blurred' by the diversity of food images included in both the low- and high-calorie food categories, resulting in weaker associative learning at the category level" (p3).

Itzkovitch et al (2022) outlined a similar intervention called "cue-approach training" (CAT) (ie: "a general tool for preference changes without external reinforcement"; p5). Training involves the GNG paradigm many times (40-60 images and 8-20 runs). Subsequently, participants are presented with a choice of a high- or low-calorie snack, say. In studies, the "Go" items were chosen "significantly above chance", and also the effect persisted up to six months after training (Itzkovitch et al 2022).

Whether the change in food choice leads to weight loss depends on the study (Itzkovitch et al 2022).

Itzkovitch et al (2022) suggested that "CAT could be beneficial in improving maladaptive food perceptions in eating disorders such as anorexia nervosa by enhancing preferences toward high-calorie foods" (p5).

15.3. APPENDIX 15A - FOOD AREAS OF THE BRAIN

Two specific areas of the brain have been found that respond strongest to images of food. Jain et al (2023) collected data on eight individuals who looked at 10 000 different pictures in a functional magnetic resonance imaging (fMRI) machine. The two areas in the brain were in the ventral visual cortex, and were close to an area known to respond to facial recognition (Murugesu 2022).

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