Evidence from randomised controlled trials does not support current dietary fat guidelines: a systematic review and meta-analysis

Zoë Harcombe,1 Julien S Baker,1 James J DiNicolantonio,2 Fergal Grace,1 Bruce Davies3

ABSTRACT
Objectives: National dietary guidelines were introduced in 1977 and 1983, by the USA and UK governments, respectively, with the ambition of reducing coronary heart disease (CHD) mortality by reducing dietary fat intake. A recent systematic review and meta-analysis by the present authors, examining the randomised controlled trial (RCT) evidence available to the dietary committees during those time periods, found no support for the recommendations to restrict dietary fat. The present investigation extends our work by re-examining the totality of RCT evidence relating to the current dietary fat guidelines.

Methods: A systematic review and meta-analysis of RCTs currently available, which examined the relationship between dietary fat, serum cholesterol and the development of CHD, was undertaken.

Results: The systematic review included 62 421 participants in 10 dietary trials: 7 secondary prevention studies, 1 primary prevention and 2 combined. The death rates for all-cause mortality were 6.45% and 6.06% in the intervention and control groups, respectively. The RR was 0.991 (95% CI 0.935 to 1.051). The death rates for CHD mortality were 2.16% and 1.80% in the intervention and control groups, respectively. The risk ratio (RR) from meta-analysis was 0.976 (95% CI 0.878 to 1.084). Mean serum cholesterol levels decreased in all intervention groups and all but one control group. The reductions in mean serum cholesterol levels were significantly greater in the intervention groups; this did not result in significant differences in CHD or all-cause mortality.

Conclusions: The current available evidence found no significant difference in all-cause mortality or CHD mortality, resulting from the dietary fat interventions. RCT evidence currently available does not support the current dietary fat guidelines. The evidence per se lacks generalisability for population-wide guidelines.

INTRODUCTION
US public health dietary advice was announced by the Select Committee on Nutrition and Human Needs in 19771 and was followed by UK public health dietary advice issued by the National Advisory Committee on Nutritional Education in 1983.2 Dietary recommendations in both cases focused on reducing dietary fat intake, specifically to (i) reduce overall fat consumption to 30% of total energy intake and (ii)...
reduce saturated fat (SFA) consumption to 10% of total energy intake.

The recommendations were intended to address mor-
tality from coronary heart disease (CHD). We recently
published a systematic review and meta-analysis, which
reported that evidence from randomised controlled
trials (RCTs), available to the dietary guideline commit-
tees, did not support the introduced dietary fat recom-
mendations. This systematic review and meta-analysis
extends this work by re-examining the totality of RCT
evidence, currently available, relating to the present
dietary fat guidelines.

While no previous study had reviewed the evidence
available to the 1977 and 1983 committees, a number of
meta-analyses have reviewed RCT and/or epidemi-
ological evidence available at their respective times of
publication. None has found any significant result
for dietary fat intervention and mortality: all-cause, car-
diovascular disease (CVD) or CHD mortality.

A meta-analysis by Skeaff and Miller in 2009 included
28 US and European cohorts (6600 CHD deaths among
280 000 participants) and found no clear relationship
between total or SFA intake and CHD events or deaths.
In 2010, Siri-Tarino et al undertook a meta-analysis of
21 prospective cohort studies involving 347 747 partici-
pants, evaluating the association of SFA with CVD. They
reported that there is no significant evidence for con-
cluding that dietary SFA is associated with an increased
risk of CHD or CVD.

Hooper et al examined RCT evidence in 2011 and
2015 and found no significant difference for total mor-
tality or cardiovascular mortality resulting from modified
dietary fat intake, reduced dietary fat intake or com-
bined modified and reduced dietary fat intake.

Chowdhury et al’s meta-analysis of RCTs and prospec-
tive cohort studies found no association of dietary SFA
intake, nor of circulating SFAs, with CHD.

Schwingshackl and Hoffmann examined RCTs that
reduced or modified dietary fat with regard to all-cause
mortality, CVD mortality and CVD events, in participants
with established CHD. They concluded that there was
no evidence for benefit of reduced/modified fat diets in
the secondary prevention of CHD.

Mozaffarian et al reported evidence that consuming
polyunsaturated fats in place of SFAs reduced CHD
events, not mortality, in RCTs.

A number of these reviews have been challenged.
Stamler posed questions following the Siri-Tarino et al
publication. Chowdhury et al’s meta-analysis received
a number of letters of response, which led to the ori-
iginal article being amended. Mozaffarian et al’s review
was criticised for excluding two unfavourable trials
and for including the non-randomised, cross-over trial
excluded by other reviews.

The most recent meta-analysis by Hooper et al sug-
gested that reduction of SFA intake may result in a small
but potentially important reduction in cardiovascular
risk, not mortality.

There were two important findings of Harcombe
et al: first, the evidence available to the dietary commit-
tees did not support the introduced guidelines; second,
the evidence available had serious limitations and was
inappropriate to use for population-wide recommenda-
tions. The six studies available in 1983 had reviewed
2467 men and no women. Five of the six studies were secondary prevention; one included
primary and secondary prevention subjects.

Based on these secondary findings, selection criteria
for meta-analysis to inform population-wide recommend-
dations should be restricted to RCTs, of sufficient size
and duration, with primary prevention subjects, man
and woman. There is only one study meeting these crit-
eria, the Minnesota Coronary Survey, and the results
of this were not significant.

As a meta-analysis cannot be undertaken on the one
primary prevention, both-sex, study available, this
follow-up study retains the selection criteria and thus
limitations of Harcombe et al to re-examine dietary
guidelines, for total and SFA, to assess their evidence
base against the RCT evidence currently available.

**METHODS**

A systematic review and meta-analysis was conducted
in accordance with the Preferred Reporting Items for
Systematic Reviews and Meta-Analyses (PRISMA)
guidelines.

**Search strategy**

A search was undertaken to identify RCTs that examined
the relationship between modified or reduced dietary
fat intake, serum cholesterol and mortality from CHD
and all-causes. Exclusion criteria were as follows: study
being observational; non-randomised and/or multi-
factorial in design. Inclusion criteria were as follows: ran-
domised dietary intervention study; study hypothesis
relating to a reduction or modification of dietary fat;
participants were human adults; study was a minimum
of 1 year in duration; primary study outcome was all-cause
and CHD mortality; and data on all-cause mortality,
CHD mortality and cholesterol measurements were
available.

Searches were performed of the literature using
MEDLINE, Embase and the Cochrane Library. AMED
and SIGLE (grey literature sources) were not relied
upon, as their periods covered were not compatible:
1985 and 1992, respectively (figure 1).

**Selection of studies**

Of 486 identified articles, 346 were rejected on review of
the title and abstract. Of these, 119 were rejected for
being review, discussion or historical articles. In total, 88
were commentaries, editorials or letters. A total of 48
were rejected for having an intervention relating to a
particular food or supplement, rather than dietary fat.
There were 30 studies where animals or children/
adolescents were the primary focus. A further 27 papers considered the design and challenges of dietary interventions, for example examining the difficulties of achieving compliance. In total, 25 were rejected for being surgical and/or pharmacological interventions. Nine related to conditions other than CHD, such as cancer and stress. Finally, 140 papers remained, of which 61 were rejected on closer inspection of the paper for being epidemiological/cohort studies and 39 were rejected for not meeting the inclusion criteria.

The remaining 40 papers covered 11 trials, once duplication was resolved. In total, 10 RCTs met the inclusion criteria: Rose Corn Oil Trial; Research Committee Low-fat Diet; Medical Research Council (MRC) Soya-bean Oil Trial; LA Veterans Study; the Oslo Diet-Heart Study; the Sydney Diet Heart Study; the dietary fat intervention from the Diet and Reinfarction Trial (DART); the Minnesota Coronary Survey; the St Thomas’ Atherosclerosis Regression Study (STARS); and the Women’s Health Initiative (WHI). Following correspondence, the PREvención con Dleta MEDitarránea (PREDIMED) study was rejected for non-availability of CHD mortality and total cholesterol data.

To ascertain the validity of eligible randomised trials, a pair of reviewers (ZH and BD) worked independently to determine which studies met the inclusion criteria. The same 10 were agreed on. Risk of bias was further assessed using the Cochrane Collaboration assessment tool for selection bias (random sequence generation, allocation concealment); performance/detection bias (blinding of participants and personnel, blinding of outcome assessment); attrition bias (incomplete data outcome); and reporting bias (selective reporting) (figure 2). Additionally, the meta-analyses for all-cause mortality (figure 3) and CHD deaths (figure 4) were tested for sensitivity analysis of the exclusion of any one study.

Data extraction

Table 1 details data extraction including study name, duration, year of publication and confirmation of study con Dleta MEDiterránea (PREDIMED) study was rejected for non-availability of CHD mortality and total cholesterol data.

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Data extraction

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Statistical analysis

The overall pooled effect was calculated using random-effects meta-analysis. Heterogeneity and bias were quantified using the I² and T² calculations, I²=100%×(Q−df)/Q, where Q is Cochran’s heterogeneity statistic and df is the degrees of freedom. Funnel plot methodology and Egger’s regression intercept were calculated. Analyses were performed using Comprehensive Meta-Analysis.

RESULTS

Participants and study design

The 10 identified RCTs included a total of 3888 deaths from all-causes and 1218 deaths from CHD among 62,421 participants (table 1). The most recent trial, the WHI, dominated the data pool with 78% of the participants, but the results remained non-significant with the exclusion of this study. Excluding this study leaves 13,586 participants and results in a risk ratio (RR) for all-cause mortality from meta-analysis of 1.005 (95% CI 0.922 to 1.097) and a RR for CHD mortality from meta-analysis of 0.962 (95% CI 0.850 to 1.089) (both random-effects methodology).

The WHI trial was a primary and secondary prevention trial for women only. The Minnesota Coronary Survey was a primary prevention study, with data for men and women reported separately. The LA Veterans Study comprised one-fifth secondary and four-fifths primary prevention subjects. The remaining studies were secondary prevention studies with exclusively male participants.

The mean duration of the 10 trials was 4.7±3.3 years. The weighted mean duration (person years by participants) was 6.8±2 years.

All trials were parallel and randomised, avoiding selection bias (figure 2). Two studies reported allocation concealment; the remaining eight were unclear for this aspect of selection bias. Eight were blinded for outcome assessment and thus at low risk of detection bias. Two were open, with no, or unclear, blinding on either side, at high risk of performance and detection bias. The LA Veterans Study was reported as double blinded, but the dietary changes were so substantial that this was
Figure 4  Estimates of total mortality (95% CIs) from meta-analysis for CHD deaths. DART, Diet and Reinfarction Trial; MRC, Medical Research Council; STARS, St Thomas’ Atherosclerosis Regression Study; WHI, Women’s Health Initiative.

Table 1  Outcome data from included trials of diet and events for intervention (Int) and control (Ctrl) groups

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Int/Ctrl</td>
<td>Type Years</td>
<td>All deaths Int/Ctrl</td>
</tr>
<tr>
<td>Rose Corn oil</td>
<td>28/26 (M under 70)</td>
<td>S 2</td>
<td>64 g corn oil/day, 58 g olive oil/day + many banned foods</td>
</tr>
<tr>
<td>Rose Olive oil</td>
<td>26/26 (M under 70)</td>
<td>S 2</td>
<td>40 g fat/day</td>
</tr>
<tr>
<td>Low-fat Diet</td>
<td>123/129 (M under 65)</td>
<td>S 3</td>
<td>85 g soya-bean oil/day + many banned foods</td>
</tr>
<tr>
<td>MRC Soy-bean Oil</td>
<td>199/194 (M under 60)</td>
<td>S 3.4</td>
<td>40% calories from fat, 2/3 fat from veg oils</td>
</tr>
<tr>
<td>LA Veterans Study</td>
<td>424/422 (M age 55+)</td>
<td>P/S 8</td>
<td>40% calories from fat, 2/3 fat from veg oils</td>
</tr>
<tr>
<td>Oslo Diet-Heart Study</td>
<td>206/206 (M 30–64 years)</td>
<td>S 11</td>
<td>40% calories from fat, 72% fat from soya-bean oil</td>
</tr>
<tr>
<td>Sydney Diet Heart Study</td>
<td>221/237 (M 30–59 years)</td>
<td>S 5</td>
<td>10% sat/15% poly vs 14% sat/9% poly</td>
</tr>
<tr>
<td>DART Fat advice</td>
<td>1018/1015 (M under 70)</td>
<td>P 2</td>
<td>Total fat 30% P/S=1</td>
</tr>
<tr>
<td>Minnesota Coronary Survey</td>
<td>4393 M</td>
<td>P 1</td>
<td>Ctrl: 39% calories fat (18% sat; 5% poly; 16% mono)</td>
</tr>
<tr>
<td>Men</td>
<td>4664 W (all ages)</td>
<td>P 2</td>
<td>Int: 38% calories fat (9% sat; 15% poly; 14% mono)</td>
</tr>
<tr>
<td>STARS</td>
<td>27/28 (M under 66)</td>
<td>S 3.25</td>
<td>27% calories fat (8–10% sat; 8% poly)</td>
</tr>
<tr>
<td>WHI</td>
<td>19 541/29 294 (W 50–79 years)</td>
<td>P/S 8.1</td>
<td>20% calories fat; 7% calories sat fat</td>
</tr>
<tr>
<td>Total</td>
<td>26 354/36 067</td>
<td>S 8.1</td>
<td>1701/2187</td>
</tr>
</tbody>
</table>

In ‘Int/Ctrl’: M, men; W, women.
In ‘Type’: P, primary prevention study; S, secondary prevention study.
In ‘Diet’: P/S, polyunsaturated:saturated fat ratio; poly, polyunsaturated fat; sat, saturated fat.
*Control not double counted.

DART, Diet and Reinfarction Trial; MRC, Medical Research Council; STARS, St Thomas’ Atherosclerosis Regression Study; WHI, Women’s Health Initiative.
implausible (egg consumption quantified, vegetable oils added and animal fats restricted). The Minnesota Coronary Survey was reported as double blinded and this was plausible given the dietary intervention.24 The open enrolment and departure in the LA Veterans and Minnesota institutions21 22 produced attrition bias. The open enrolment and departure in the LA Veterans and Minnesota institutions21 22 produced attrition bias. The STARSD28 was judged unclear for attrition bias for the relatively high number of dropouts in small participant numbers. All studies were judged low risk for reporting bias, as there was no evidence of any data being withheld (figure 2).

The meta-analyses for all-cause mortality (figure 3) and CHD deaths (figure 4) were tested for sensitivity analysis of the exclusion of any one study. There were no circumstances in which the exclusion of any one study made the overall effect size significant.

There was little evidence for between-study heterogeneity. For all deaths, the Q-value was 7.915 (11 df), but this was not statistically significant; p=0.721. F was 0.000 and T² was 0.000, indicating no difference in true effects. For CHD deaths, the Q-value was 9.173 (11 df), but this was also not statistically significant; p=0.606. F was 0.000 and T² was 0.000.

Visual inspection of the funnel plots revealed that one study was touching the outside of the SE funnel for the meta-analysis of all deaths and CHD deaths. The two, small, oil interventions14 produced asymmetry on the lower right-hand side of the funnel, which was countered by the small STARS representation on the lower left-hand side.28 The Egger’s regression test indicated no statistically significant asymmetry for all-cause mortality and CHD deaths. The Egger’s regression intercept was 0.337 (95% CI, two-tailed, −0.489 to 1.163) (one-tailed p=0.192; two-tailed p=0.384) for all-cause mortality and 0.380 (95% CI, two-tailed, −0.756 to 1.517) (one-tailed p=0.237; two-tailed p=0.473) for CHD deaths.

Interventions and comparisons

A total of 6 of the 10 RCTs did not examine either of the introduced dietary guidelines: a total fat consumption of 30%; or a SFA consumption of 10%, of energy intake.14 18–21 29 Four trials examined the administration of vegetable oil,14 18 20 21 to effect reduced intake of animal fat. The Research Committee Low-fat Diet19 and the WHI29 studied an approximate 20% fat diet. Woodhill et al20 and Frantz et al22 reviewed the consequence of a 10% SFA diet, without the total fat dietary guideline restriction. Woodhill et al reported higher incidence of all-cause mortality and CHD deaths in the intervention group. Frantz et al recorded no difference in all-cause mortality or CHD deaths. The DART27 tested a 30% total fat diet although this was not a controlled variable, as the intervention also tried to achieve a 1:1 polyunsaturated to SFA ratio. The STARS28 was the first to examine targets approximating to those set by dietary guidelines with a total fat consumption of 27% and an 8–10% SFS intake.

Outcomes: all-cause mortality

Across 10 studies, containing 12 dietary interventions, involving 26 354 participants in the intervention groups and 36 067 participants in the control groups, there were 1701 deaths in the intervention and 2187 deaths in the control groups. All-cause mortality was 6.45% in the intervention groups and 6.06% in the control groups.

For all-cause mortality, the WHI study29 carried the greatest weight, 54.35% (figure 3; random-effects methodology). Three studies, comprising four interventions, carried a combined weight of 35%.20–22 The Rose et al14 corn and olive oil interventions had negligible impact on the overall effect, with weights of 0.04% and 0.07%, respectively, as did the STARS with a weight of 0.07%.28 The RR for all 12 interventions was 0.991 (95% CI 0.935 to 1.051). The overall effect measurement lies on the line of no effect. There was no statistically significant difference between dietary interventions and all-cause mortality.

CHD mortality

The 12 interventions recorded 568 deaths from CHD among 26 354 participants in the intervention groups and 650 deaths from CHD among 36 067 participants in the control groups. The death rates for CHD mortality were 2.16% and 1.80% in the intervention and control groups, respectively. The forest plot for the dietary interventions and deaths from CHD produced the meta-analysis shown in figure 4 (random-effects methodology).

For CHD mortality, the WHI study29 carried the greatest weight, 27.59% (figure 4; random-effects methodology). The Oslo study20 was comparable with a weight of 21.36% and the DART27 contributed 15.56% to the weighting. The Rose et al14 corn and olive oil interventions had negligible impact on the overall effect, with weights of 0.14% and 0.24%, respectively, as did the STARS with a weight of 0.23%.28 The RR for all 12 interventions was 0.976 (95% CI 0.878 to 1.084). The overall effect measurement lies on the line of no effect. There was no statistically significant difference between the dietary interventions and heart deaths.

Serum cholesterol levels

Mean serum cholesterol levels decreased in all groups, control and intervention, except for the DART,27 where cholesterol levels were 1.2% higher in the control group after 2 years. This was unlikely to be clinically relevant.35 None of the reductions in mean serum cholesterol levels exceeded the critical difference of 19%, calculated by Fraser and Fogarty35 as the requirement for significance (p<0.05).

Three studies alone15 27 28 reported SDs and significance for the start and end-of-study mean serum cholesterol levels. The one figure reported as statistically significant was the 14% reduction in mean serum cholesterol levels in the intervention group in the STARS (p<0.001).28 The 8-year WHI study29 reported the
reductions in mean serum cholesterol levels in the intervention and control groups as 10.2±32.0 mg/dL and 6.9±31.9 mg/dL, respectively, and reported the difference between the reductions, 3.26 mg/dL, as significant at p<0.05 from a 2-sample test.

The standardised mean difference in serum cholesterol levels, for the 10 trials (12 interventions) combined, was −11.4±6.5% for the intervention groups and −4.7%±4.8% for the control groups (table 1). The effect size was 1.18.

DISCUSSION

The main findings of our systematic review and meta-analysis are that currently available RCT evidence does not support the current dietary fat guidelines. RCT evidence indicates that dietary modification may reduce serum cholesterol to a marginally greater extent in intervention groups, compared with controls. However, this reduction in serum cholesterol does not appear to translate into an improved survival from all causes or CHD.

Design limitations

As noted in the introduction, the fundamental design limitation of dietary fat interventions available to inform public health advice is that only one study has been undertaken involving men and women without previous heart disease. All other RCTs have been single-sex and/or secondary prevention studies.

The method of extracting dietary information was a limitation of all studies. Dietary recall is generally unreliable and 24-hour recall may not be representative of usual diet. Dietary surveys, where food is weighed at the time of being recorded, are also unreliable.

Woodhill et al noted that it is ‘insuperable’ to isolate dietary factors in a secondary prevention study. This is a flaw of all secondary prevention studies, not a unique flaw of this study. The study noted that changes in smoking habit, dietary pattern, body weight, lifestyle and physical activity before and after entry to the trial may have had a significant effect on prognosis (page 326).

There are some additional design limitations among the available RCTs, which may confound interpretation. A number of studies impaired assessment of the primary dietary intervention by adding other dietary restrictions, such as the avoidance of processed foods. This would impact industrially produced trans fat intake, which is associated with CHD. The low-fat diet resulted in the calorie intake in the intervention group ranging between 330 and 780 calories fewer than that of the control group. At the largest differential, observed after 4 years of the study, the diet group was consuming 70% of the calorie intake of the control group. This study reported mean weight loss as 7.5% in the intervention group and 4.8% in the control group. This may have favoured the intervention outcomes. The STARS claimed that its dietary fat above 32% of total calorie intake.

Study conclusions

Only one of the 10 RCTs presented a case for dietary guidelines. The STARS claimed that its findings supported the use of a lipid-lowering diet in men with CHD. The 5-year review of the Oslo Diet-Heart Study concluded that the cholesterol-lowering diet reduced the incidence of total CHD relapses. The conclusion after 11 years was more reserved: that sudden death in survivors of myocardial infarction was uninfluenced by diet.

Four studies were neutral in their findings. The MRC study found no evidence from the London Veterans Study recorded the lowest RR for CHD deaths for the intervention group: 0.816 (95% CI 0.552 to 1.206) (figure 3). However, there were important differences in the groups at study entry, favouring the intervention outcomes: 2.8% of the intervention group were octogenarians, compared with 5% in the control group; 11% of the intervention group were heavy smokers (more than one pack a day) compared with 17% of the control group.

Additional limitations were the short duration (1 year) of the second largest study, the Minnesota Coronary Survey with 9057 participants. Two of the studies were small, although meta-analysis weights this accordingly. Leren benefited from trial length, but the study discussion noted that the test groups were too small to be significant for fatal incidences. The summary also reported that CHD mortality was correlated with age, blood pressure, body weight, smoking habits and a combination of these factors, meaning that the association with diet alone could not be isolated.

The WHI study was of substantial size and duration, but with a number of confounding variables. It was limited in its focus on postmenopausal women, aged between 50 and 79, and who were not already consuming dietary fat below 32% of total calorie intake. Participants were additionally invited to receive hormone therapy and participation in a calcium/vitamin D supplement trial was offered after 1 year. This study alone included cholesterol-lowering medication, which was taken by 12% of participants in the intervention and control groups.

A limitation of the meta-analysis of the 10 studies combined was that all RCTs differed in duration; number of participants; nature of intervention; other factors held constant and subject age groups, undermining possible conclusions, although the statistical homogeneity helps to mitigate concerns.
reductions, but concluded that two to three portions of fatty fish each week may reduce mortality in men who have recovered from a myocardial infarction. The Minnesota Coronary Survey\textsuperscript{22} found no differences between the treatment and control groups for cardiovascular events, cardiovascular deaths or total mortality. The WHI\textsuperscript{29} reported that an 8.2% energy decrease in total fat intake had been achieved and a 2.9% energy decrease in SFA intake, but that this did not reduce risk of CHD.

The other four studies issued cautions about the safety and/or efficacy of their interventions.\textsuperscript{14 15 19 21} Rose \textit{et al}\textsuperscript{43} reported that corn oil was most unlikely to be beneficial, and was possibly harmful. The Research Committee\textsuperscript{19} concluded that a low-fat diet has no place in the treatment of myocardial infarction. Dayton \textit{et al}\textsuperscript{31} noted the absence of any benefit for longevity and expressed concern about toxicity of the intervention. Woodhill \textit{et al}\textsuperscript{45} reported that survival was significantly better in the control than the diet group.

This meta-analysis of 10 RCTs, in comparison with Harcombe \textit{et al}'s review of 6 RCTs,\textsuperscript{5} increased the number of people studied from 2467 to 62 447. It increased the number of women studied from 0 to 53 499, the majority. It increased the number of primary prevention subjects from 676\textsuperscript{21} to 56 291. However, 83% of the primary prevention subjects were postmenopausal women, so the concern about generalisability remains for guidelines introduced for whole populations.

**Review of dietary guidelines**

The US dietary guidelines advisory committee (DGAC) report was published in February 2015.\textsuperscript{41} The recommendation to limit dietary cholesterol intake to 300 mg a day has prevailed in the USA since 1977.\textsuperscript{1} The DGAC stated that they will not bring forward this recommendation, because available evidence shows no appreciable relationship between consumption of dietary cholesterol and serum cholesterol.\textsuperscript{41} The UK did not introduce dietary cholesterol targets in the original guidelines\textsuperscript{2 42} and they have not been introduced since.\textsuperscript{45}

The DGAC advice demonstrated further movement away from the original dietary guidelines by containing no total fat recommendation and a change in position on dietary fat and CVD. The advisory report documented the findings of the meta-analyses by Skeaff,\textsuperscript{4} Siri-Tarino,\textsuperscript{5} Hooper\textsuperscript{6} and Chowdhury,\textsuperscript{8} and concluded that reducing total fat does not lower CVD risk.\textsuperscript{41} The SFA guideline was reiterated, however, with the recommendation to consume <10% of total calories from SFA per day.\textsuperscript{41}

The UK does not review dietary guidelines at regular intervals. The target for total fat remains 30% of daily total energy intake and 10% for SFA.\textsuperscript{43}

Dietary fat guidelines were introduced with the intention of reducing CHD mortality. No meta-analysis has found any significant difference for dietary fat interventions and all-cause mortality or deaths from CHD.\textsuperscript{3-8 10 44} All but one study,\textsuperscript{22} is of single-sex and/or secondary prevention subjects. Even in men who have already suffered a myocardial infarction, evidence does not support dietary recommendations; yet they have been issued for millions of citizens for three to four decades.

The most recent meta-analysis,\textsuperscript{7} with the same single-sex, secondary prevention limitations, suggested that there may be a small reduction in cardiovascular risk on reduction of SFA intake. It was further suggested that replacing the energy from SFA with polyunsaturated fat appeared to be a useful strategy, while replacement with carbohydrate appeared less useful and replacement with monounsaturated fat unclear. Of the 11 interventions contributing to this conclusion, only one documented both SFA reduction and reported that this was mainly replaced with polyunsaturated fat.\textsuperscript{21}

The future will undoubtedly consist of the tailoring of diets and lifestyle to individual genomic make-up.\textsuperscript{45} This will require the understanding of the genomic structure of circulating lipid profiles and replicable data on genes and diet interaction. Caution will be required in translating contemporary research on gene diet and lifestyle into public health advice.

It is important that we learn from the study limitations and lack of evidence on which current guidelines are based and not make the same mistake with future guidelines or suggestions. Harcombe \textit{et al}\textsuperscript{5} found that the dietary fat guidelines were not evidence based. This paper reiterates the finding and recommends that national dietary advice needs urgent review.

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**Contributors** ZH conceived of the study and was the major contributor to data extraction, writing of the manuscript and the meta-analysis. BD was involved in data extraction, writing of the manuscript and the meta-analysis. Other authors were involved in critical evaluation of content.

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**REFERENCES**


