Public Health England

Protecting and improving the nation's health

Obesity and fitness

The relation between obesity, cardiorespiratory fitness and mortality

Briefing paper

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Summary

- There is strong evidence to show a positive association between obesity and increased risk of mortality
- However, some people are classed as obese and also have good cardiorespiratory fitness; based on the available evidence, such ‘fat and fit’ groups appear to have lower risk of mortality compared to ‘healthy weight and unfit’ people
- The lowest risk group in most studies is among the ‘healthy weight and fit’ groups
- At a population level it is likely that there are few people classed as obese who have high enough levels of cardiorespiratory fitnesss to reduce their mortality risk
- The most consistent and evidence-based public health message therefore remains that the greatest health benefit comes from being a healthy weight, with good cardiorespiratory fitness
- As well as reducing risk of mortality, being a healthy weight with good cardiorespiratory fitness is likely to improve many of the health conditions associated with excess weight
- The best way to achieve a healthy weight and good cardiorespiratory fitness is to combine physical activity at recommended levels with a healthy diet
- However improving cardiovascular fitness through regular moderate to intense physical activity is likely to reduce mortality risk for normal, overweight and obese groups whether this is achieved with or without weight reduction

Introduction

There is strong evidence to show a positive association between obesity (BMI≥30kg/m^2) and increased risk of mortality.[1,2,3] However, the relation is not straightforward. While the vast majority of studies find that increasing BMI is associated with increasing risk of mortality, it is possible that the nature of this relation is confounded by other factors that are not adequately measured. There is a strong evidence base describing the impact of metabolic factors (such as lipid profile, glucose tolerance, blood pressure and waist circumference) on mortality independent of BMI.[4] However, there is increasing recognition of the role of cardiorespiratory fitness,[5] especially in people who are classified as obese but have high levels of cardiorespiratory fitness. There is evidence that such individuals have lower risk of mortality than people classified as normal weight but with low cardiorespiratory fitness. This has been described as one of the 'obesity paradoxes'.[6]

This paper presents recent review-level evidence behind the relation between obesity, cardiovascular fitness and mortality, and briefly explores the main public health implications.

Cardiorespiratory fitness: review-level evidence

Cardiorespiratory fitness is a health-related component of physical fitness defined as the ability of the circulatory, respiratory and muscular systems to supply oxygen during sustained physical activity. Cardiorespiratory fitness is usually expressed in metabolic equivalents (METs) or maximal oxygen uptake (VO_2 max) measured by exercise tests such as treadmill or cycle ergometer.[5]

The link between obesity, cardiorespiratory fitness and mortality was first documented in the late 1990s.[7,8] However, the research evidence on the potential role of fitness in reducing mortality risk among obese populations is not extensive, probably because so few prospective studies measure fitness. Instead, it has been more common to rely on objective or self-reported measures of physical activity behaviour, or measurement of CVD risk fators. Studies that have measured fitness have tended to rely on sub-maximal tests (ie estimating maximal oxygen uptake from participants who exercise to 85% of their age-predicted maximum heart rate rather than to exhausation).[9]

The studies that use well-validated measures of cardiorespiratory fitness provide clear evidence of a positive relationship between cardiorespiratory fitness and mortality. Evidence from a meta-analysis (33 studies comprising 102,980 participants, with 6910 all-cause deaths, and 84,323 participants with 4485 CVD events in men and women) found that each 1-MET increment in cardiorespiratory fitness (corresponding to approximately 1km/h higher running/jogging speed) was associated with a 13% and 15% risk reduction from all-cause mortality and CVD events, respectively.[10]

However, the evidence for the relative contributions of cardiorespiratory fitness and obesity to health outcomes is controversial.[11] Some studies find that a moderate to high level of fitness eliminates the higher risk of mortality associated with obesity,[8] while others report that both fitness and obesity are independent predictors of mortality[12] or that fitness and fatness had similar associations with all-cause and CVD mortality.[13]

The authors of a comprehensive review on this topic (supported by an unrestricted research grant from The Coca-Cola Company) [5], concluded:

- “cardirespiratory fitness appears to attenuate the higher risk of death associated with obesity although it is not clear whether fitness completely eliminates mortality risk in obese individuals”

- “the highest risk of mortality is observed in those who are both obese and unfit; therefore, health professionals should encourage these patients to engage in regular physical activity to develop and maintain cardiorespiratory fitness, whether or not it makes them thin”

The first meta-analysis on this topic has recently been published.[14] This aimed to quantify the joint association of cardiorespiratory fitness and weight status on mortality from all causes, using ten papers found from systematic searching. This body of evidence comes from thousands of participants, although the authors noted that some of the studies were not rated as high quality. The meta-analysis found that, compared to normal weight fit individuals, unfit individuals had twice the risk of mortality regardless of BMI. Overweight and obese fit individuals had similar mortality risks as normal weight fit individuals. Hazard ratios for three categories of BMI and two categories of fitness are shown below.

Figure 1: Hazard ratios (95% confidence intervals) for all-cause mortality[14]

	Normal weight	Overweight	Obese
Fit	**1**	**1.13** (1.000-1.27)	**1.21** (0.95-1.52)
Unfit	**2.42** (1.96-2.99)	**2.14** (1.77-2.58)	**2.46** (1.92- 3.14)

Prevalence

It is important to consider the prevalence of the ‘fat and fit’ phenotype. If this is rare in the UK population, then it may not be a major consideration for population-level public health strategies.

It is difficult to assess the extent of the ‘fat and fit’ population with any degree of accuracy. As the Health Survey for England (HSE) measured (sub-maximal) fitness in 2008, this might be used to estimate the prevalence (with secondary analysis of raw HSE data). However, this would be hampered by a lack of a standard definition of fitness that is used in both cross-sectional surveys and longitudinal studies. The HSE did find that cardiovascular fitness was lower on average among those who were obese (32.3ml O2/min/kg among men, 28.1 ml O2/min/kg among women) than among those who were neither overweight nor obese (38.8 ml O2/min/kg and 33.9 ml O2/min/kg respectively). It also found that levels of fitness were generally low: 32% of men and 60% of women were classed as ‘unfit’ (could not walk at 3mph up a 5% incline). It therefore seems unlikely that there is a high proportion of people in the general population who are obese but have a high enough level of cardorespiratory fitness to confer the levels of mortality benefit seen in some of the studies above.

A study in the US estimated that 9% of obese individuals registered high fitness,[15] while in Finland, researchers estimated that a metabolically healthy but obese phenotype was observed in 9.2% of obese men and in 16.4% of obese women.[16] If this were translated to the England population it would be equivalent to 2.2% of all men and 4.1% of all women being classed as obese and fit.

Public health implications

- The majority of the population would benefit their health by losing weight, as obesity is associated with a range of health problems in addition to increased risk of mortality
- High levels of cardiorespiratory fitness – achieved through regular participation in physical activity at recommended levels[1] – reduce the risk of mortality among people of all body weights
- It appears to be 'better to be fat and fit than it is to be fat and unfit'. However this area of research is relatively new and limitations in the evidence available mean that more research is needed to confirm this conclusion
- The available evidence also suggests that the'fat and fit' group are at lower risk than the 'normal weight and unfit' group
- However, the lowest risk of all is among the non-obese and fit population
- At a population level it is likely that there are few people classed as obese who also have high enough levels of cardiorespiratory fitnesss to reduce their mortality risk. Although some people are in this situation, the great majority of overweight and obese people do not have good cardiorespiratory fitness. The existence of this subgroup of people should not significantly affect population level responses to overweight and obesity
- It remains the case that the greatest health benefit comes from being a healthy weight, with good cardiorespiratory fitness. As well as reducing risk of mortality, this is likely to improve many of the health conditions associated with excess weight
- The best way to achieve this is to combine physical activity at recommended levels with a healthy diet
- However, an important public health message for people who are overweight or obese is to engage in regular moderate and vigorous intensity physical activity to develop and maintain cardiorespiratory fitness, whether or not it helps them lose weight. This should be combined with appropriate dietary messages

[1] Most of the papers referred to in this briefing note are from the USA, where the DHHS 2008 Physical Activity Guidelines recommend 150 minutes of moderate intensity physical activity per week, which can be accumulated in doses of 10 minutes or more. This is almost identical to current UK recommendations.

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