



What scope is there for averting the adverse health effects of obesity?

Investigating the role of physical activity

- A substantial proportion of the British population is now at risk of obesity-related ill-health.
- Policies to halt the rising trend in obesity are important, but action is needed simultaneously for the generations already affected. A key public health priority is therefore to minimise obesity-related health consequences.
- Using longitudinal data from the 1958 British birth cohort, this study investigated whether physical activity and sedentary behaviour are potential modifying influences on the risk of obesity-related disease.
- The research found that there are benefits of delaying onset of overweight and obesity, in that the risks of developing diabetes were lower for 45 year-olds becoming overweight or obese in the previous decade than for those with childhood onset. Therefore, interventions to prevent obesity are best targeted in childhood.
- Further analyses suggest that lack of activity and frequent TV-viewing are behaviours to target in preventive strategies that seek to lessen the impact of obesity on risk of diabetes and cardiovascular disease in British adults.
- This research has focussed only on physical activity and sedentary behaviour as potential modifying influences on the association between obesity and biomarkers for cardiovascular disease and diabetes. Further research to improve understanding of how to lessen the impact of obesity on associated disease risk is warranted.

Background

A substantial proportion of the British population is now at risk of obesity-related ill-health. Around a fifth of men and a quarter of women were identified as obese in the *Health Survey for England* in 2009.

Policies to halt the rising trend in obesity are important, but action is needed simultaneously for the generations already affected. A key public health priority is therefore to minimise obesity-related health consequences. In this context, potentially important modifiable factors include physical activity and sedentary lifestyles, which have been related to cardiovascular disease (CVD) and type 2 diabetes.

Improved understanding is needed of health benefits that might accrue from activity or reduced sedentary behaviour across different life-stages when changes in lifestyles or adiposity occur. From a public health perspective, it is important to identify the benefit to obese groups of increased activity or reduced sedentary behaviour.

Methods

This research is based on data collected prospectively as part of the 1958 British birth cohort, covering all born in England, Wales and Scotland, during one week in 1958. Participants are survivors from an original sample of over 17,000 births, followed-up by parental interview and examination throughout childhood and by interview in adulthood. During childhood, individuals were traced through schools and immigrants born in the reference week were added to the sample. The first biomedical assessment in adulthood was conducted at age 45 (n=9337).

Our objective was to identify whether health consequences of obesity are modifiable by physical (in)activity; specifically:

- Whether the effects of obesity on biomarkers for CVD and diabetes are modifiable by physical activity; for example, whether individuals who are obese, but regularly physically active in adulthood, are at lower risk of obesity-related disease than individuals with less active lifestyles.

- Whether both the level and change in physical activity in early adult life affect the association between obesity and biomarkers for CVD. And whether the timing of activity is important to establish whether “it is never too late” to alter health outcomes.

Full details of our research methods can be found on the PHRC website (www.york.ac.uk/phrc/).

Key findings

Approximately 25% of the population were obese by age 45, and of this group, most (59%) had onset in mid-adulthood, whilst 7.6% were obese from childhood. Around one in ten were identified as obese when aged 33.

At 45yrs, most of the population participated in moderate-vigorous leisure activity, with 38% active on several occasions (≥ 6) per week. More than 1 in 5 reported TV-viewing for more than 3 hours a day, whilst 43% reported sitting at work for more than 3 hours a day.

Obesity and CVD biomarkers†

In both men and women, obesity at age 33 was associated with higher systolic and diastolic blood pressure (SBP and DBP), glycated haemoglobin (HbA1c) and triglycerides and with lower HDL cholesterol, and in women only, with higher LDL cholesterol* all measured twelve years later at age 45. The estimates were obtained from analyses that allowed for other potential confounding factors, such as diet, smoking and education level.

Adults with overweight or obesity onset in childhood or young adulthood had the highest mean BMIs and waist circumference at age 45, and greatest risk of elevated HbA1c. Childhood obesity onset was associated with an almost 24-fold risk of HbA1c $\geq 7\%$ compared to the never obese, and there was a 22-fold risk for the more prevalent group with childhood overweight onset.

Associations between earlier onset of overweight or obesity and adult HbA1c levels were largely due to the greater adiposity at age 45 of those with earlier onset. These findings are important given

*blood pressure (systolic, SBP and diastolic, DBP); glucose metabolism (indicated by glycated haemoglobin, HbA1c) and blood lipids, namely: total-cholesterol, Low-density lipoprotein (LDL) and High-density lipoprotein (HDL) cholesterol and triglycerides.

young children today are overweight earlier in their lives than previous generations.

For a minority of overweight children who were not overweight in adulthood, average levels and risk of HbA1c \geq 6% were not elevated, suggesting that detrimental effects of childhood overweight can be averted if BMI gain with increasing age can be controlled. However, those who were obese in childhood and not thereafter had a five-fold risk of HbA1c \geq 7% or type 2 diabetes, even after adjustment for adiposity at age 45.

Sedentary behaviour and CVD biomarkers

For women total and LDL cholesterol, triglycerides, systolic and diastolic blood pressure (SBP and DBP) were higher by 0.8% to 4.5% and HDL was lower by 2.0% per category increase of TV-viewing (i.e. 0-1, 1-2, 2-3 and >3 hours/day);

For men, triglycerides, SBP and DBP were higher by 0.4% to 4.5% and HDL was lower by 2.3% per increase in TV-viewing category.

No association was seen for HbA1c and most, but not all, associations were partly mediated by BMI. Associations for sitting at work tended to be weaker.

Physical activity and sedentary behaviour over different ages in adulthood

For blood pressure, there was little evidence of a trend across frequency of activity, rather there was a threshold associated with (dis)benefit for active versus inactive (e.g. not active in last month at age 23 or <2-3 times/month at age 33).

Physical activity at age 23 to 45y was associated with lower SBP and DBP and reduced risk of hypertension.

Associations tended to be linear for lipid measurements, e.g. HDL increased by 0.006mmol/L and triglycerides decreased by 1.4% for each day/week of activity participation at age 42. Few associations were found for total or LDL-cholesterol.

Many, but not all, associations attenuated with adjustment for BMI, suggesting a salient mediating role for adiposity. There was some evidence to suggest an influence of activity participation decades before BP and lipid measurement at 45y:

e.g. 23y activity was associated with lower risk of hypertension and in women, with higher HDL-cholesterol. For BP, there was some suggestion of cumulative associations: early adult activity was associated with hypertension independently of recent activity, which was also associated with BP.

In men for example, prevalence of hypertension was highest in those who were inactive at both 23 and 45 years (39%) and lowest in those who were active at both ages (31%). Thus, there may be benefits of becoming active and cumulative benefits of sustaining active lifestyles over many years.

Similarly, TV-viewing at 23 and 45 years were both associated independently with SBP, DBP and hypertension for men, suggesting a cumulative association.

For lipids, support for cumulative benefits of activity was more limited and no cumulative association for TV-viewing was found.

Combined and interacting associations between physical activity (or sedentary behaviour), obesity and biomarkers for CVD and type 2 diabetes

For obesity, associations were largely independent of activity, TV-viewing and other covariates, with biomarker levels estimated to be ~4 to ~27% higher for the obese group. TV-viewing associations attenuated after adjustment, often substantially, but some biomarkers were associated independently, with levels elevated by ~1 to ~5% for those watching >3hours/day. Weaker associations for physical activity were largely attenuated after adjustment for covariates.

We found some support for moderating associations of activity and TV-viewing on the association of obesity with HbA1c. In obese men, HbA1c levels at 45y were lowered as frequency of moderate-vigorous activity increased, whereas the association was weak in non-obese men. For both sexes, the TV-viewing and HbA1c association was stronger for the obese, such that mean HbA1c levels increased with greater hours of TV-viewing; associations in the non-obese were weak.

Preliminary results suggest that there may be a similar moderating association of

activity on the obesity/blood pressure relationship, with a stronger protective association of activity for the obese. Little support was found for moderating associations on the obesity and blood lipids associations.

Conclusions

Whilst based on observational data, with the limitations that this imposes, this study has notable strengths owing to availability of longitudinal data offering decades of follow-up. The research has the following implications for public health prevention strategies:

(1) the risks of elevated HbA1c were lower for 45 year-olds becoming overweight or obese in the previous 12 years than for earlier onset, highlighting the need to prevent early life onset of overweight and obesity;

(2) blood lipids were adversely associated with sedentary behaviour, although most notably with TV-viewing. Given that TV-viewing was associated with other biomarkers and also clusters with CVD-related lifestyles and socio-demographic

factors, it may be an important modifiable risk factor to target;

(3) the association of lack of activity in early adulthood with blood pressure and blood lipids subsequently at age 45, in some instances with cumulative (age 23 and 45) associations, suggests that there are benefits of becoming active and sustaining activity over many years of life;

(4) the stronger associations for HbA1c among obese than non-obese groups, protective for activity and detrimental for TV-viewing, argues for changes in these behaviours to lessen the impact of obesity on risk of type 2 diabetes.

Our study has focussed only on physical activity and sedentary behaviour as potential modifying influences on the association between obesity and CVD/diabetes biomarkers. Given this, further research to improve understanding of how to lessen the impact of obesity on associated disease risk is warranted.

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