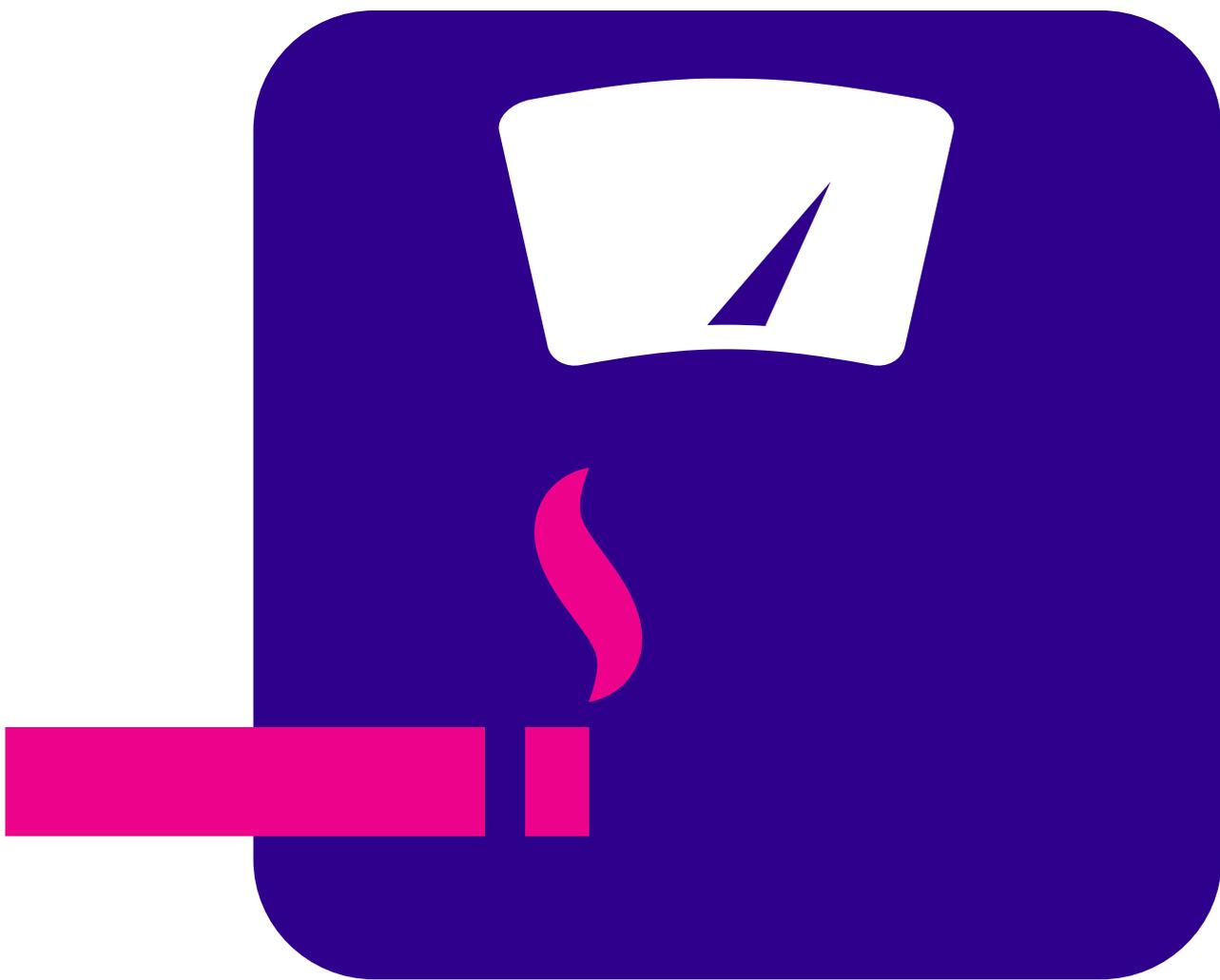


WHEN COULD OVERWEIGHT AND OBESITY OVERTAKE SMOKING AS THE BIGGEST CAUSE OF CANCER IN THE UK?

Cancer Intelligence Team, Policy & Information Directorate,
Cancer Research UK, September 2018



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Glossary

Incidence: The number of new cases (e.g. of cancer) diagnosed in a specific time period (e.g. 2035).

Lag: Time required for risk factor exposure to impact on cancer incidence.

Microsimulation: A projection method which simulates individuals representative of population groups through the life course to estimate future outcomes (<http://www.ukhealthforum.org.uk/who-we-are/our-work/modelling/about-microsimulation/>).

Population Attributable Fraction (PAF): The percentage of cancer cases attributable to a risk factor.

Prevalence: The percentage of the population with a specified characteristic (e.g. current cigarette smokers, or overweight people) at a specific point in time.

Projections: Estimates of future outcomes (e.g. disease incidence, risk factor prevalence) based on past trends; may be made using various statistical methods.

Relative risk (RR): The extent to which exposure to a risk factor (versus absence of exposure, or versus a specific reference level of exposure) increases or decreases cancer risk.

EXECUTIVE SUMMARY

Introduction

Smoking is currently the biggest cause of cancer in the UK with overweight and obesity the second biggest. Smoking prevalence has fallen over recent decades, whilst overweight and obesity prevalence has risen. Projections indicate these past trends will continue in future. This report brings together available trends and evidence to understand whether overweight and obesity could contribute more UK cancer cases than smoking in the foreseeable future.

Method

This report uses the established epidemiological method of Population Attributable Fractions (PAFs) to combine projections of cancer incidence, smoking prevalence and overweight and obesity prevalence, in order to calculate the number and proportion of UK cancer cases attributable to each factor in 2025-2035, based on risk factor prevalence 10 years prior (e.g. risk factor prevalence in 2025 impacts cancer incidence in 2035).

Results

The number of overweight and obesity-attributable cancer cases is projected to draw ever-nearer to the number of smoking-attributable cancer cases. By 2035 overweight and obesity could contribute only around 2,000 fewer cancer cases than smoking, in UK females. In UK males, projections indicate around 16,200 cases could separate the two risk factors in 2035.

Based on these calculations, we estimate that overweight and obesity could cause more cancer cases than smoking in UK females by 2043.

Discussion

This is the first attempt to quantify and compare the future smoking- and overweight and obesity-attributable cancer burdens in the UK. The method is well-established and the data inputs are of high quality. However these calculations are based entirely on projections which are by their nature uncertain; they may exclude some risk factor-cancer type relationships which are only becoming clear in recent years; and they may underplay the long-term impact of risk factors. Whilst a 'crossover' between smoking and overweight and obesity appears almost inevitable if recent trends continue, the precise point at which this will occur is difficult to predict, and the results presented here are indicative rather than definitive.

Conclusion

Overweight and obesity could overtake smoking as the single biggest cause of cancer in UK women in around a quarter of a century, if current trends continue as projected. For UK males this crossover is likely to occur later, but it is not possible to estimate a timeframe for this as it is too far in the future to project reliably. Together, smoking and overweight and obesity could cause more than 95,000 UK cancer cases in 2035 alone – compared with around 75,000 cases in 2015.

Our success as a nation in bringing down smoking prevalence, through a combination of raising awareness of the harms of the habit, and legislating to reduce accessibility and exposure, shows that these approaches work. It is CRUK's aim to reverse the rise in overweight and obesity prevalence. These calculations demonstrate just how vital that aim is to reduce the number of people diagnosed with cancer in the UK in future.

INTRODUCTION

Smoking is currently the biggest cause of cancer in the UK, accounting for 15% of cases in 2015. Overweight and obesity (henceforth 'overweight/obesity') is currently the second biggest cause of cancer in the UK, accounting for 6% of cases in 2015.¹ Smoking has a much greater effect on cancer risk than does overweight/obesity at individual level, but because the latter is much more prevalent than the former, their population-level impacts are not so dissimilar.

There are marked sex differences, with the gap between smoking and obesity as causes of cancer much narrower for females than for males. For UK males, 18% of cancer cases are caused by smoking and 5% by overweight/obesity – a 13 percentage point gap between the causes. For UK females, 12% of cancer cases are caused by smoking and 7% caused by obesity – only a 5 percentage point gap between the causes.

This sex difference is due to variation between males and females in past risk factor prevalence, and the contribution of sex-specific or sex-dominant cancer types to the total number of cancer cases. Smoking-related cancer types make up a larger proportion of cancer cases altogether in males than they do in females, because of higher smoking rates in males. Overweight/obesity is also more common in males than females, however there is greater impact of obesity on

cancer in the female population is because several female-specific (uterine and ovarian) or female-dominant (breast) are caused by excess body weight.

In the UK smoking prevalence has been falling for decades,² while overweight/obesity prevalence has been rising.^{3,4,5,6} Accordingly, the proportion of UK cancer cases attributable to smoking fell by one percentage point overall (2.2 percentage points decrease in males and 0.2 percentage point increase in females) between 2010 and 2015, while the proportion attributable to overweight/obesity rose by 0.2 percentage points (0.1 percentage point decrease in males and 0.3 percentage point decrease in females).^{1,7}

Projections suggest that UK smoking prevalence will continue to fall, and overweight/obesity prevalence will continue to rise.^{8,9} Still, with smoking currently contributing over twice as many UK cancer cases compared with overweight/obesity, a 'crossover' in terms of cancer impact is expected to be some years away.

This report combines projected prevalence of smoking and overweight/obesity, with projected cancer incidence, to explore whether/when the latter could contribute more UK cancer cases than the former.

METHOD

Population attributable fractions (PAFs) were calculated using the established formula, as used by Parkin et al and Brown et al.¹⁰ Briefly, the formula combines risk factor prevalence, cancer incidence, and relative risk of cancer in risk factor-exposed versus unexposed people, to calculate the number of cases attributable to the risk factor; the number of attributable cases is then divided by the total number of cases to obtain the attributable fraction.

Separate PAFs were calculated for each combination of risk factor, cancer type and sex. Attributable cases were summed to obtain PAFs for all cancers combined. A ten-year lag was assumed between risk factor exposure and cancer incidence, e.g. risk factor prevalence in 2025 was used to calculate PAFs for 2035. Inputs to the calculation are described below.

Cancer type-risk factor combinations

Cancer types classified by the International Agency for Research on Cancer (IARC) as having a definite causal association with smoking or overweight/obesity were included in the calculations. The cancer types included for smoking were acute myeloid leukaemia, bladder, bowel, cervical, kidney, laryngeal, liver, lung, mucinous ovarian, nasopharyngeal, oesophageal adenocarcinoma (AC), oesophageal squamous cell carcinoma (SCC), oral cavity, pancreatic, pharyngeal, stomach.¹¹ The cancer types included for overweight/obesity were bowel, breast, endometrial, gallbladder, kidney, liver, meningioma, myeloma, oesophageal AC, ovarian, pancreas, stomach cardia, thyroid.¹²

Cancer incidence

Cancer incidence projections for the UK based on incidence data from 1979-2014 were used.¹³ The projections run to 2035; it is considered unreliable to project cancer incidence too far into the future given the possible impact of new prevention interventions, diagnostic techniques, etc. The impact of risk factors is included implicitly in these projections, in that past risk factor prevalence

impacted past cancer incidence, and past cancer incidence impacts future cancer incidence projections.

Projections were not available for some of the specific cancer subtypes associated with smoking or overweight/obesity according to IARC: the PAF calculations required oral cavity, pharynx, mucinous ovarian cancer, oesophageal adenocarcinoma, oesophageal squamous cell carcinoma, acute myeloid leukaemia, gastric cardia cancer, endometrial cancer, and meningioma; projected incidence of these subtypes was estimated from projected incidence of oral cavity and pharynx combined, ovarian, oesophageal, leukaemia, stomach, uterine, and brain, other central nervous system (CNS) and intracranial tumours. These estimates were made by applying the contribution of the subtype to the broad cancer type in the UK in 2013-15, to the projected broad cancer type data; these calculations were made by five-year age band and sex.

Smoking prevalence

Projections of smoking prevalence ('current smoking' e.g. smoking during each projected year) were made by UK Health Forum using a microsimulation model assuming a continuation of trends observed in 2010-2016.⁸ Data were broken down by five-year age bands and sex. Projections were made for each UK nation separately and were aggregated to UK level for this analysis. Weighted averages were created, broken down by five-year age band and sex, with weighting by Office for National Statistics (ONS) population estimates/projections for 2015-25 for each country.¹⁴

Projections of ex-smoking prevalence were not available so estimates were made for this analysis using the UK-aggregated projections of current smoking prevalence. Ex-smoking prevalence was calculated by 'tracking' cohorts through the current smoking prevalence projections data, subtracting the proportion of current smokers in one period from the proportion of current smokers in the same cohort in the previous period. For example projected current smoking prevalence was 12% among 60-64 year-olds in 2020, and 20% among 55-59 year-olds in 2015, meaning that between those two periods 8% of current smokers had quit. For each cohort the calculated proportions of quitters in each period were summed across the lifetime to create the total proportion of ex-smokers in each age group.

Overweight/obesity prevalence

Projections of overweight/obesity prevalence were made by UK Health Forum using a microsimulation model assuming a continuation of trends observed in 2000-2012.⁹ Data were broken down by five-year age bands and sex. Projections were made for England only. These England figures were used to estimate Scotland, Wales and Northern Ireland figures, by calculating the ratio of overweight/obesity prevalence in each devolved nation versus England, on average in 2014-16, split by sex and ten-year age band;^{3,4,5,6} and then applying those ratios to the projected England overweight/obesity prevalence. The projected England and estimated devolved nations figures were aggregated to UK level for this analysis. Weighted averages were created, broken down by five-year age band and sex, with weighting by ONS population estimates/projections for 2015-25 for each country.¹⁴

Relative risk

Relative risk estimates were identified through a systematic literature search in 2017, these are reported elsewhere.¹ Most of the relative risk estimates were drawn from meta-analyses.

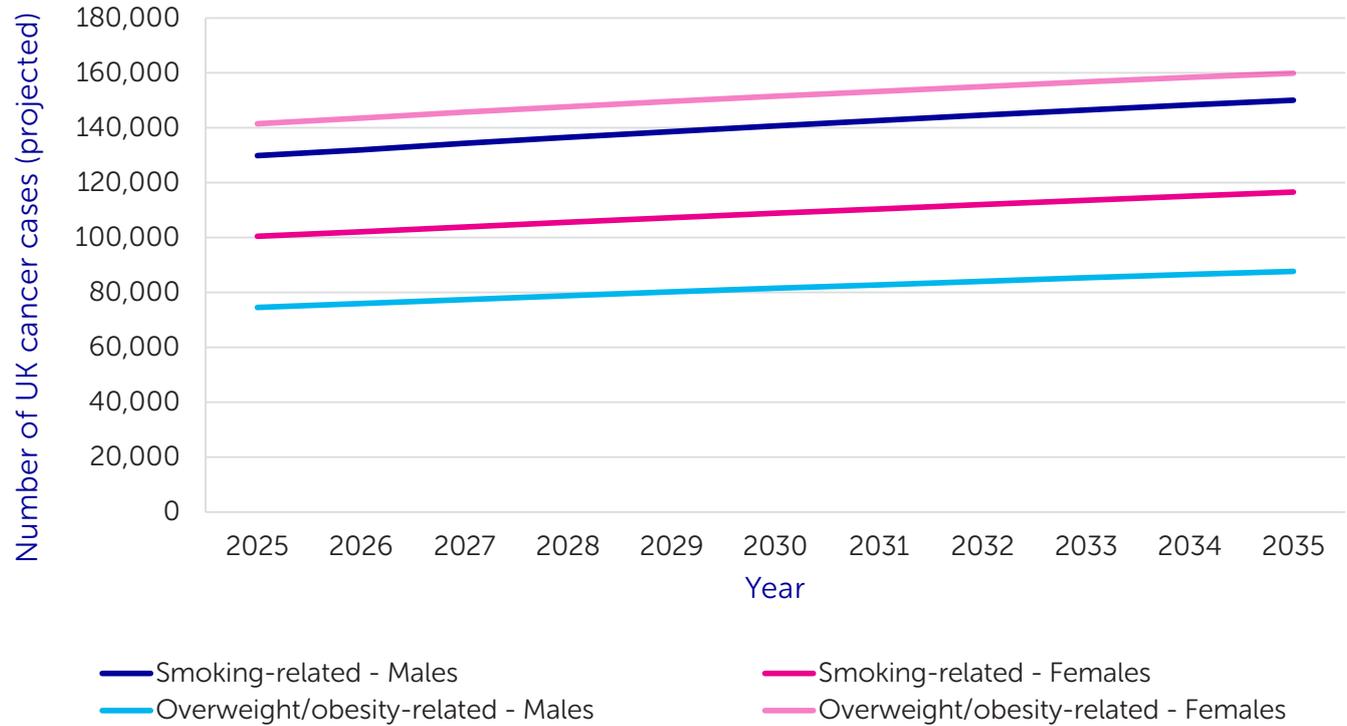
RESULTS

Summary of data inputs

Incidence of smoking-related cancer types (the cancer types overall, not specifically cases of those cancers attributable to smoking) is projected to increase by 16% in both males and females in the UK between 2025 and 2035 (Figure 1). Incidence

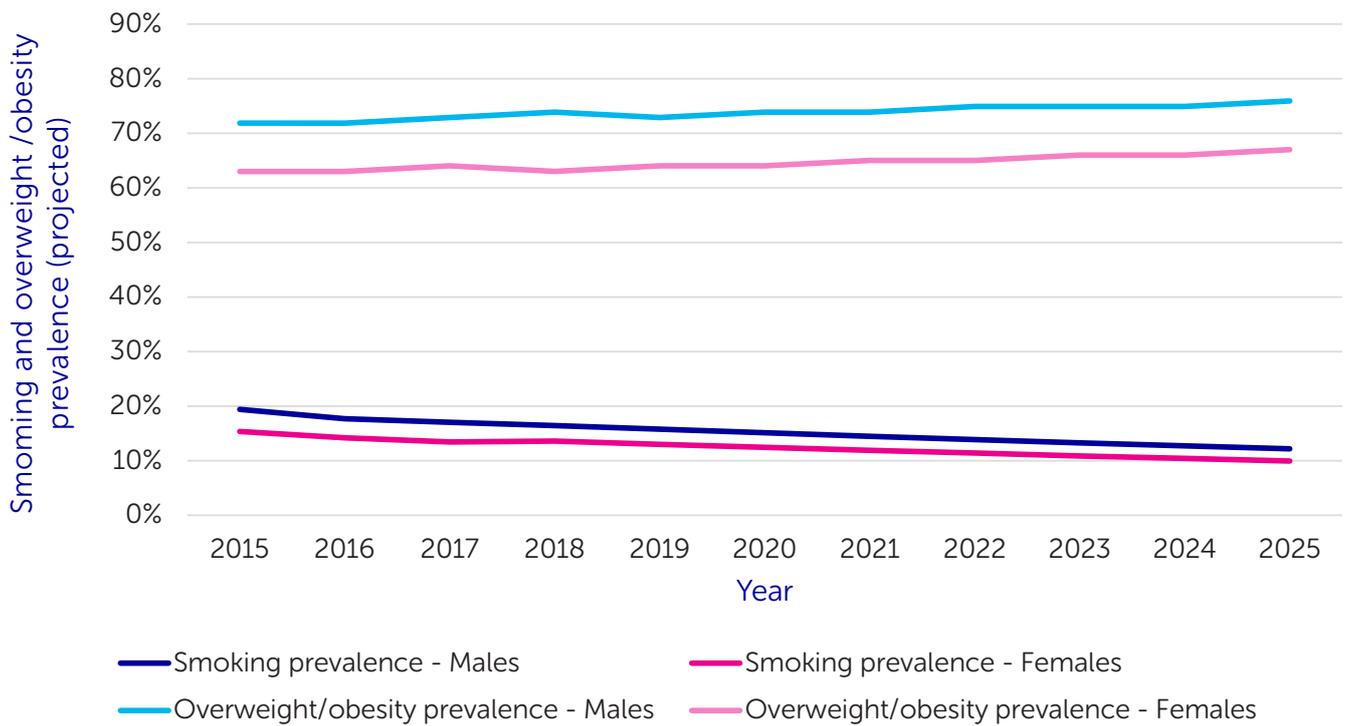
of overweight/obesity-related cancer types (again the cancer types overall) is projected to increase by 18% in males and 13% in females in the UK between 2025 and 2035.

Figure 1. Incidence (cases) of smoking- and overweight/obesity-related cancer types, by sex, UK projections, 2025-2035



Prevalence of smoking in the UK is projected to decrease by 37% in males and 35% in females between 2015 and 2025 (Figure 2). Prevalence of overweight and obesity in the UK is projected to increase by 6% in both males and females between 2015 and 2025.

Figure 2. Prevalence of smoking and overweight/obesity, by sex, UK projections, 2015-2025



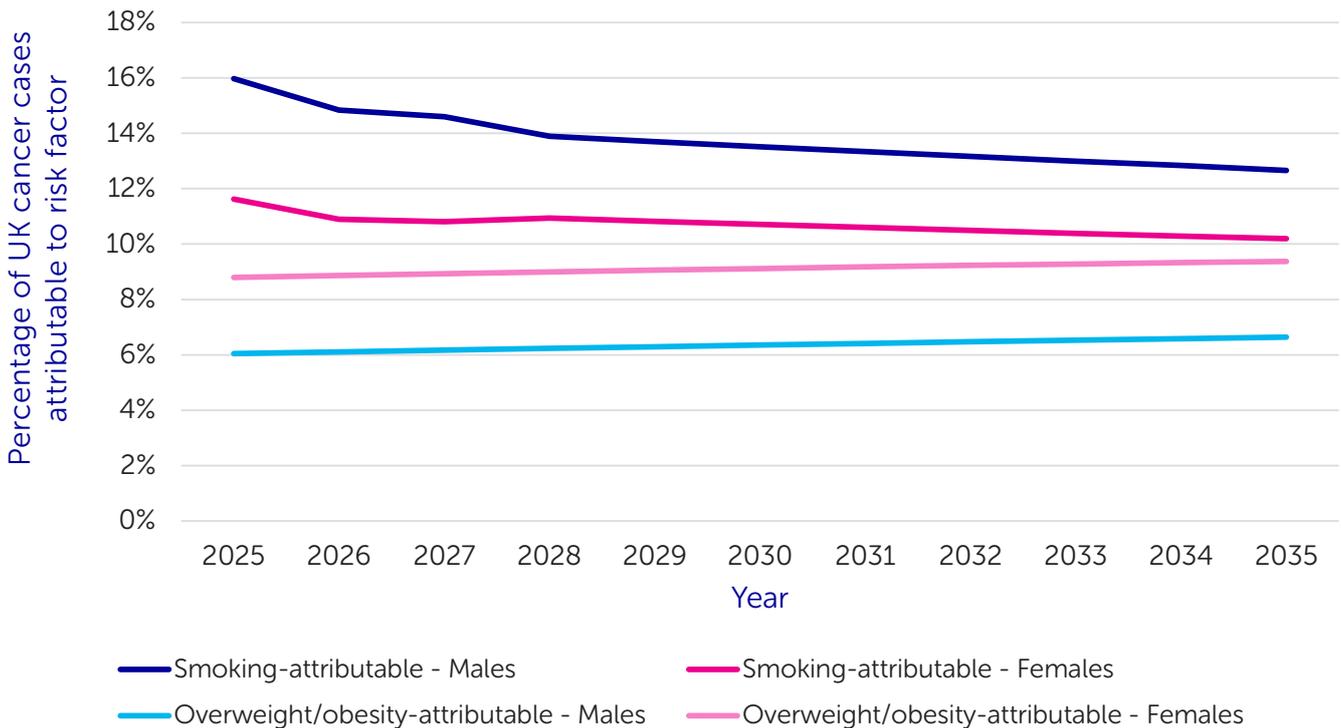
Smoking- and overweight/obesity-attributable cases

If current trends continue, the UK persons PAFs for smoking could decrease from 13.9% in 2025 to 11.5% in 2035, while the PAFs for overweight/obesity could increase from 7.4% in 2025 to 7.9% in 2035 (Figure 3).

For females, PAFs for smoking and overweight/obesity could be only 0.8 percentage points apart by 2035. For males the gap could remain wider in 2035, at 6.0 percentage points.

For smoking, the PAF decrease between 2025 and 2035 could be larger in males (3.3 percentage points) than females (1.4 percentage points), partly reflecting the higher starting point for males (16.0% versus 11.6%). For overweight/obesity, the PAF increase over time could be similar in females and males (both 0.6 percentage points), reflecting the expected similar pace of increase in overweight/obesity prevalence.

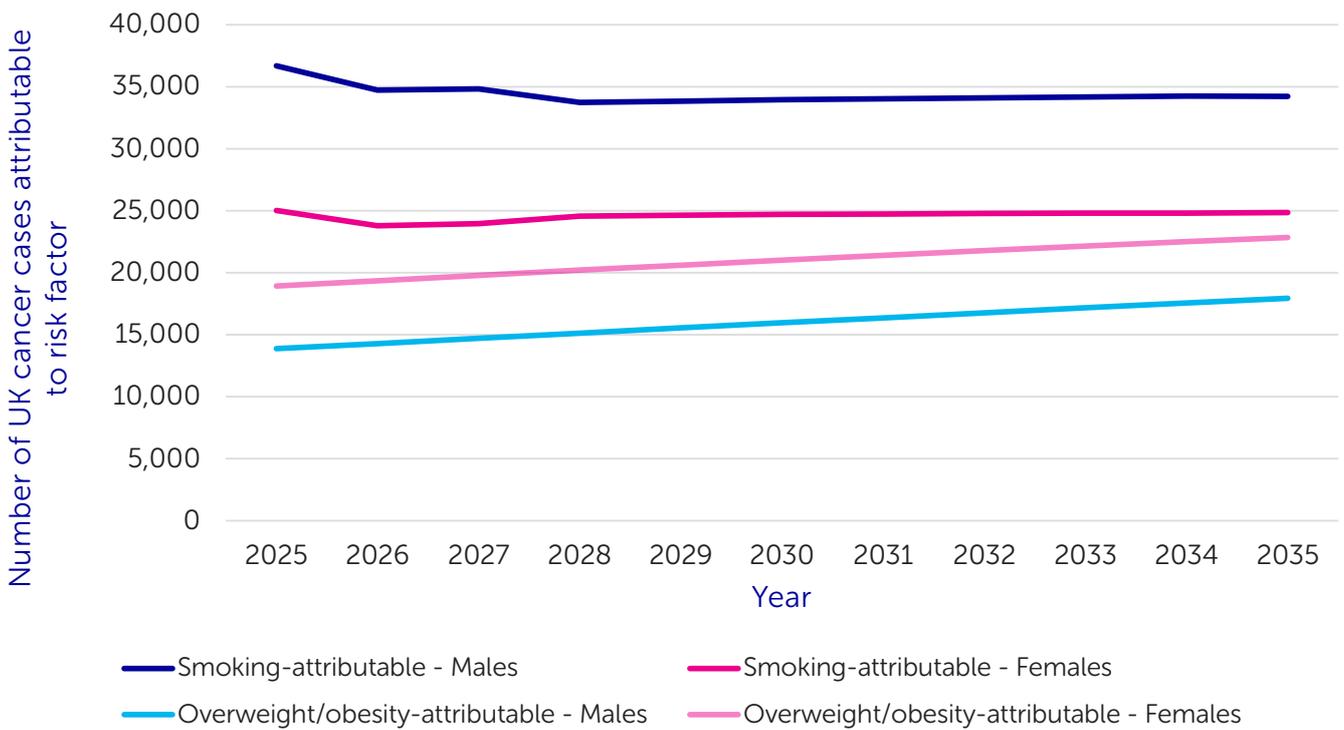
Figure 3. Population Attributable Fractions (PAFs) for smoking and overweight/obesity, by sex, UK projections, 2025-2035



The number of UK cancer cases caused by smoking is projected to fall slightly, from around 61,700 in 2025 to around 59,100 in 2035. The number of cases caused by overweight/obesity is expected to rise slightly, from around 32,800 in 2025 to around 40,800 in 2035 (Figure 4).

For UK females there could be around 2,000 cases difference between the smoking-attributable and overweight/obesity-attributable totals in 2035. For UK males the difference could be much larger, at around 16,300 cases.

Figure 4. Cancer cases attributable to smoking and overweight/obesity, by sex, UK projections, 2025-2035



In 2035, smoking and overweight/obesity together could cause around 95,200 cancer cases in the UK. This total takes into account that cancer cases may have more than one cause and so is slightly less than a simple sum of the two factors' attributable cases.¹

DISCUSSION

Key findings

If recent smoking and overweight/obesity prevalence trends continue, the latter could contribute around 2,000 fewer cases than the former in UK women by 2035. Based on these calculations, we estimate overweight/obesity could cause more cancer cases than smoking in UK females by 2043 (see appendix 1).

In UK men this 'crossover point' could probably occur some years later, but this cannot be established with current projections. Similarly in men and women combined it is not possible to establish when the crossover could take place.

The fall in smoking and the rise in obesity would need to be markedly faster in males than in females for the crossover point to happen at the same time in both sexes. Currently the smoking-obesity gap is larger in males than females – and the larger the gap, the longer it will take to close.

This sex difference relates to risk factor prevalence and variation in common cancer types between males and females. Smoking has a bigger effect on overall cancer incidence in the male population, because smoking-related cancer types make up a higher proportion of total cancers in males than females, and smoking prevalence is and always has been higher in males than females. Overweight/obesity has a greater impact on female cancer incidence despite it too being more common in males, because it is closely associated with a number of female-only or female-predominant cancer types.

Projections indicate both these patterns of cancer incidence and risk factor prevalence will persist in future hence the sex difference in smoking-obesity gap will also persist.

Strengths and limitations

This is, to our knowledge, the first attempt to quantify the future burden of cancer in the UK caused by smoking and overweight/obesity. The PAF method used here is well-established, and the data included in the calculations is high-quality. Estimating the future burden of preventable cancer is important to motivate prevention efforts, and to support service planning.

The work is not without shortcomings. The calculations assume a ten-year lag between risk factor exposure and cancer incidence. Evidence on lag time is sparse, particularly for obesity, however the relative risk figures used in these calculations are typically derived from studies with around ten years follow-up therefore are appropriate for use with the ten-year lag used here. Still, if the impact of one risk factor is concentrated in the early years of exposure while the impact of the other is concentrated in the later years, the choice of lag could have impacted the comparisons reported here.

The cancer type-risk factor combinations used in these calculations are based on IARC classifications, and those classifications are much older for smoking than for overweight/obesity. Others have argued that evidence is now sufficiently strong for a causal association between smoking and more cancer types. The inclusion of additional cancer types for smoking would obviously increase the smoking PAF and therefore delay the 'crossover point' to some extent.

The smoking and overweight/obesity projections are not directly comparable as they are based on slightly different time periods and geographies. The overweight/obesity projections may prove to be a slight overestimate as overweight/obesity prevalence has remained fairly stable since the period on which the projections are based; 2015 and 2016 data indicate the projections may be a few percentage points too high so far.^{3,4,5,6} The smoking projections may be more accurate as smoking prevalence was falling steadily during the period on which the projections are based; 2016 and 2017 data indicate the projections are accurate so far.²

Projected incidence of some cancer subtypes was calculated assuming that the ratio of subtype to whole will not change in future (due to lack of historical morphology data to reliably predict future ratios); if this assumption proves incorrect the impact is likely to be similar for both risk factors so the 'crossover point' results are unlikely to be affected.

The calculations do not include exposure to secondhand smoke, as no projections are available. This is not expected to markedly affect the results. In 2015 secondhand smoke (exposure in 2005) accounted for only 0.1% of all UK cancer cases. Since the 2006-07 UK bans on smoking in enclosed public places, secondhand smoke exposure has fallen markedly, so the proportion of cancer cases caused by secondhand smoke in 2035 is likely to be less than 0.1%.

The calculations were made at UK level, rather than aggregated from separate constituent nations figures. The smoking, overweight/obesity, and cancer incidence projections each had different geographical breakdowns, and transforming all three to UK level required the least manipulation, with the strongest basis for the manipulation which was needed. However each UK nation is likely to have slightly different future trends in cancer incidence, smoking and overweight/obesity prevalence, and UK-level calculations underpinned by the unique combinations of these variations may have yielded slightly different results to those reported here. Because the calculations are made at UK level the results reported here are not directly comparable with those reported elsewhere for cancer incidence in 2015;¹ they are overall slightly higher because they apply UK risk factor prevalence (which is higher than England risk factor prevalence) to UK cancer incidence (the majority of which is England cases).

CONCLUSIONS

Overweight and obesity could overtake smoking as the UK's single biggest cause of cancer in around a quarter of a century for females, if current trends continue as projected. For males the crossover is likely to occur later. Together these risk factors could cause more than 95,000 UK cancer cases in 2035 alone.

Our success as a nation in bringing down smoking prevalence, through a combination of raising awareness of the harms of the habit, and legislating to reduce accessibility and exposure, shows that these approaches work. It is CRUK's aim to reverse the rise in overweight and obesity prevalence. These calculations demonstrate just how vital that aim is to reduce the number of people diagnosed with cancer in the UK in future.

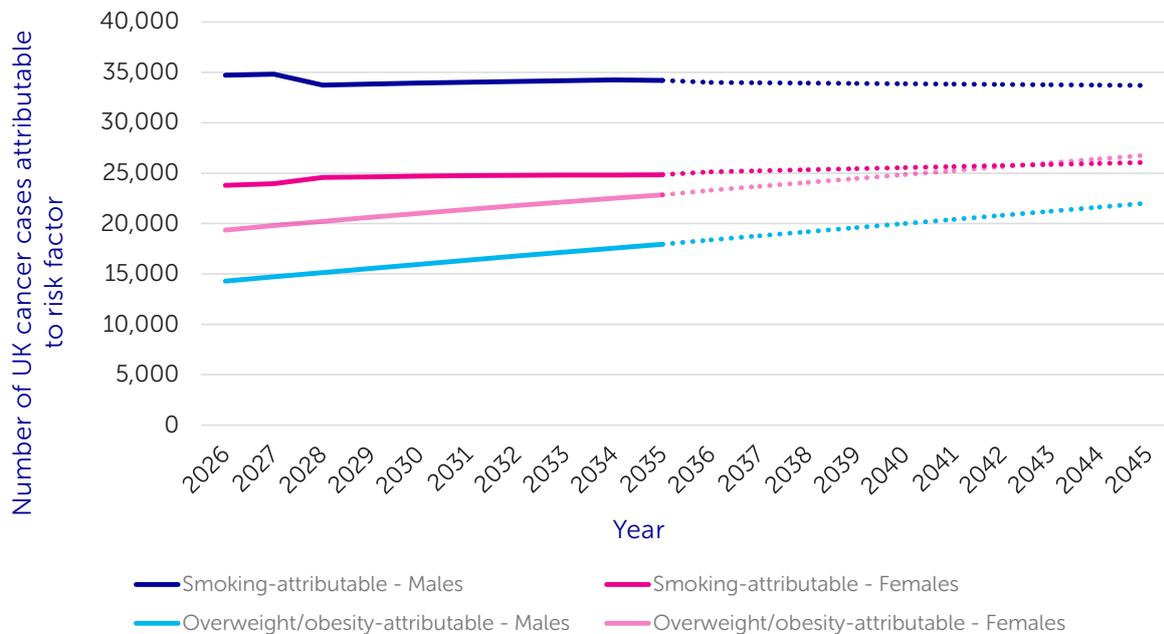
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APPENDIX 1: ESTIMATING WHETHER OVERWEIGHT/OBESITY COULD OVERTAKE SMOKING AS BIGGEST CAUSE OF CANCER BEYOND 2035

The calculations presented in the main report use cancer incidence projections to 2035, which are based on observed cancer incidence to 2014. Cancer incidence projections have not been calculated beyond 2035 for the UK.

In order to estimate if overweight/obesity would overtake smoking as the biggest cause of cancer in the UK, it is possible to extrapolate the number of UK cancer cases attributable to these risk factors from the calculations made to 2035 using linear regression.



Appendix Figure 1. Cancer cases attributable to smoking and overweight/obesity, by sex, UK projections 2026-2035, linear extrapolation 2036-2045

This linear extrapolation shows smoking attributable cases continuing at a similar number of cases beyond 2035. The number of cancer cases attributable to overweight/obesity is projected to continue increasing.

With the UK's ageing population, the number of cases of cancer expected each year is increasing for both sexes. For the projections of attributable cases up to 2035, the decrease in smoking prevalence is largely offset by the underlying increase in the number of cancer cases. The number of cases caused by smoking is expected to fall at some point in the future as smoking prevalence decreases further and isn't offset by the increase of cancer from our ageing population.

The increase in cancers attributable to overweight/obesity is predominantly due to the ageing population as well as the prevalence of overweight/obesity, which has been slightly increasing and has been projected to increase further.

It is also possible to estimate cancer incidence beyond 2035 by applying the age-specific rates projected for 2035 to population numbers projected in 2036-2045. These projected cancer cases can then be combined with projected smoking and overweight/obesity prevalence in 2026-2035, to estimate smoking- and overweight/obesity-attributable cancer cases in 2036-2045. Using this method shows a very similar increase for cases attributable to overweight/obesity but would produce a slight decrease in smoking attributable cases. The linear extrapolation is a preferred method given the lack of cancer incidence projections beyond 2035.

These estimates suggest that overweight/obesity may overtake smoking as the leading cause of cancer in UK women by 2043 if trends continue as currently projected but it would still be many more years before a similar crossover was seen in males.

