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*Revised in 2022 to take account of additional data published by HSE. However, the numbers of teacher and nurse mesothelioma deaths have not been modified.

Mesothelioma deaths in teachers and nurses in Great Britain

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Many schools and hospitals constructed or renovated during the post-war period were likely to have had asbestos installed in their structures to provided fire resistance, noise attenuation or robust wall boards. Crocidolite was widely used until the latter 1960s. Amosite was used in numerous applications such as thermal insulation and asbestos insulating boards until about 1980. Chrysotile would also have been used in asbestos cement and flooring products until the mid-1990s. Asbestos cement products could contain crocidolite until the mid-1969s or amosite until the later 1970s. Consequently, notwithstanding current HSE guidance, asbestos cement products installed prior to about 1980 cannot be considered to have contained chrysotile only.

Note that currently HSE does not define what "none detected" means regarding the crocidolite, tremolite or amosite content of asbestos samples during bulk analysis.

Given the higher potency of the three above types of asbestos for causing mesothelioma as compared with chrysotile, it is suggested that the "none detected" figure should be set at less than 0.1% of the chrysotile content of each sample.

As mesothelioma can result from environmental levels of exposure to crocidolite or amosite., e.g. Newhouse and Thompson (1965), it is considered relevant to assess whether teachers and nurses have experienced more mesothelioma deaths than would be expected in equal numbers of age and gender-matched persons not exposed to asbestos in the general population.

From HSE (2013) between 2002 and 2010 125 secondary, primary and nursery teachers and 64 nurses died from mesothelioma.

In the HSE occupational statistics the total number of "Observed" mesothelioma deaths is assigned proportionally to the total number of age and gender-matched deaths in each occupation and is presented as the "Expected" number of deaths for each occupation. The number of "Observed" deaths is then divided by the number of "Expected" deaths and multiplied by 100 to give the "Proportional Mortality Ratio", (PMR), so that any occupation where the "Observed" equals the "Expected" has a PMR of 100.

The Observed, Expected and PMR figures for teachers and nurses for the period 2002 and 2010 are shown below:

Occupation	Gender	Observed	Expected	PMR
Teachers, secondary, primary and nursery	**Male** **Female** **Total**	**68** **57** **125**	**~105.5** **~56.4** **~162**	**~64** **~101** **~77**
Nurses	**Male** **Female** **Total**	**12** **52** **64**	**26.0** **60.9** **~87**	**~46** **~85** **~74**

As can be seen, the PMR for female teachers is 101, i.e. effectively the "Expected" figure and all other relevant PMR in the occupations of interest are below about 85, i.e. lower than "Expected"

It should be noted that the above mesothelioma data record deaths to age 74 only and that currently such deaths account for only about 50% of all mesothelioma deaths, e.g. see HSE (2017a, b). That is, the true figures for teachers and nurses to age 90+ will be about twice the number of deaths tabulated above.

HSE (2003) commented that for hypothetical populations not exposed to asbestos the PMR would be 6 for males and 36 for females.

If the above "Expected" figures are multiplied by 0.06 for males and 0.36 for females the above table can be corrected as below:

Occupation	Gender	Observed	Corrected Expected	Corrected PMR
Teachers, secondary, primary and nursery	**Male** **Female** **Total**	**68** **57** **125**	**6.3** **20.3** **~27**	**~1100** **~280** **~460**
Nurses	**Male** **Female** **Total**	**12** **52** **64**	**1.6** **18.7** **~20**	**~760** **~280** **~320**

From the corrected data teachers and nurses had about 5 and 3 times respectively more mesothelioma deaths than expected in populations not exposed to asbestos.

For persons who never professionally disturbed asbestos-containing materials there are two likely causes of developing mesothelioma; exposure to asbestos in buildings containing asbestos-containing materials and idiopathic mesothelioma.

In buildings containing asbestos-containing materials in good condition airborne fibre concentrations are typically about 0.0005 fibres/ml, DoEnv (1986, 1983), Massey et al (1997). Although such a concentration appears to be very low it is low only because of the volume unit chosen and is actually 500 fibres per cubic metre: the volume unit used in describing almost every other airborne contaminant. Since the average child and adult inhales about 5-10 cubic metres per school day they will inhale about 2,500-5,000 fibres per school day if exposed to about 0.0005 fibres/ml.

Before any analysis of the mesothelioma deaths it is necessary to appreciate that for those retired or not in work the occupation entered in the death certificate was the last reported employment and that the occupational death figures only apply up to age 74 as occupation is not entered into the records after that age in England or Wales. The data therefore do not cover anyone who had previously been a teacher or a nurse and had changed careers or left to have a family and either never returned to work or took up a different career after their family went to school.

If it were assumed that teachers and nurses generally entered their careers at about age 20, had spent about 30 years working only in buildings containing asbestos-containing materials in good condition and so had been exposed to about 0.0005 fibres/ml throughout that period, their lifetime cumulative exposure would have been about 0.015 fibre/ml.year and their average risk of developing mesothelioma would have been about 60 and 3 per million to age 80 if exposed to amosite or chrysotile respectively. Note that for a uniform 30 year exposure to asbestos exposures during the first 6-7 years of exposure are responsible for about half the total mesothelioma risk and exposure in the last 10 years contributes about 10% the risk, Hodgson and Darnton (2000).

On the above assumption of periods of 30-50 years from initial exposure to asbestos and deaths from mesothelioma between 2002-2010, the exposures to asbestos would have occurred between about 1960 and about 1980. Such period would have included the period when amosite was widely used in thermal insulation and to provide fire resistance.

A search for data on teacher numbers from government websites failed to identify any such data for the period of interest.

However, Whitaker's Almanacks (1960, 1972, 1986, 2002) provided relevant data, primarily for maintained schools in England only. If it were assumed that in England state schools employed about 85% of all teachers in England and that England employed about 85% of all teachers in Great Britain, total teacher numbers would have been about: 1958 - 430,000; 1970 - 530,000; 1985 – 512,000: about 500,000 mean. From Hawe (2008) the number of staff in NHS nursing and midwifery services was about: 1961 - 250,000; 1971 - 360,000; 1980 -500,000. If it were assumed that 80% of nurses where employed in the NHS the overall average of nurses would have been about 500,000. However, it should be noted that all qualified nurses would have received their training in hospitals at the ages at which their exposure to asbestos would have been highly significant in terms of mesothelioma risk.

From the above it will be assumed there were an average of about 500,000 teachers and nurses during the likely period of exposure that was responsible for the observed mesothelioma deaths during the period 2002-20010.

Assuming a mesothelioma risk of about 60 per million to age 80 from amosite in asbestos-containing materials in good condition in buildings there would have been about 30 mesothelioma deaths in each of teachers and nurses.

Given that 125 teachers and 66 nurses up to age 74 died from mesothelioma over the period 2002-2010 teachers and nurses experienced about 4 and 2 times higher mesothelioma deaths respectively than would be expected from typical asbestos fibre

concentrations in buildings containing asbestos-containing materials in good condition.

Many cancers can result without influence from external sources. Such cancers are generally called idiopathic. Tan and Warren (2009, 2011) concluded that for mesothelioma the idiopathic rates for males and females were both about 1.1 per million per year.

However, analysis of the number of female mesothelioma deaths by Local Government Districts for the period 1976-1991* indicated that for 91 areas with a total female population of about 3.9 million had zero reported mesothelioma deaths, HSE (c1996). That is, the “background” mesothelioma rate for these 91 Areas would have been about 0.02 per million per year: about a factor of about 50 lower than suggested by Tan and Warren (2011).

*The above data were selected as being from a period late enough that diagnosis of mesothelioma should have been fairly secure and early enough to avoid the rapidly increasing number of mesothelioma deaths from the mid-1990s onwards. Note that any idiopathic rate should be independent of the period selected.

From HSE (2017) <2% of mesothelioma deaths up to age 74 during the period 2002-2010 occurred below age 49. It can therefore be assumed that for both males and females the idiopathic risk to age 74 will be about 25 years x 0.02 = 0.5 per million. That is, for populations of about 500,000 persons up to age 74 the number of idiopathic mesothelioma deaths in each profession would be about 0.3, i.e. about 60 times lower than the number of mesotheliomas caused by being in buildings containing asbestos-containing materials in good condition.

As the epidemiological data cannot distinguish idiopathic mesotheliomas from those caused by environmental exposures to asbestos, it is possible that some of the "idiopathic" mesotheliomas assessed by Tan and Warren (2009, 2011) may actually have been caused by exposure to levels of asbestos fibres in buildings and the general environment rather than being true idiopathic deaths.

In conclusion, the number of teacher and nurse mesothelioma deaths observed in Great Britain between 2002 and 2010 substantially exceeded the number of deaths expected in populations not exposed to asbestos, from exposure to asbestos-containing materials in good condition or from idiopathic mesotheliomas in the general population.

The observed excess mesothelioma deaths suggest that both teachers and nurses were likely to have been exposed to airborne asbestos fibre concentrations significantly higher than typical in buildings containing asbestos-containing materials in good condition.

From Hodgson and Darnton (2000) the likely cumulative exposures over 30 years would need to have exceeded the equivalent of about 0.15 fibres/ml.years of amosite for teachers or about 0.06 fibres/ml.years of amosite for nurses to cause the number of observed mesothelioma deaths in each profession during the period of interest.

The above figures indicate that airborne asbestos fibre concentrations in both schools and hospitals need to be assessed using programmes of high sensitivity sampling, in combination with the use of analytical Transmission Electron Microscopy (TEM); which can differentiate between the different types of asbestos and between asbestos and non-asbestos fibres, and that remedial action will be required if exposures to asbestos are likely to cause mesothelioma risks in excess of the idiopathic level.

TEM should be used to analyse all asbestos fibres, not only fibres longer than 5um and fibres wider than 0.2um, as adopted by HSE's Health and Safety Laboratories, e.g. Burdett (2012), to identify whether control actions are necessary.

It should be stressed that counting only optically visible fibres less than 3 um in diameter, longer than 5 um and with length:diameter ratio >3:1/ was selected as simplifying counting and minimising errors between different observers, e.g. see Addingley (1966).

These counting criteria were NOT selected as identifying “harmful” fibres.

If, in a given building, all TEM-visible fibres are counted and no asbestos fibres are detected; the asbestos-induced mesothelioma risk will be zero or very low. However, if asbestos fibres are detected, even if all the asbestos fibres observed are shorter than 5 um and/or all are less than 0.2 um diameter; the asbestos-induced mesothelioma risk will not be zero and control measures will/may be required.

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