

chapter 1

Basic Concepts

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Meeting the Public Health Competences

This chapter will help you to evidence the following competences for public health (Public Health Skills and Career Framework):

- Level 5(g): Understanding of basic terms and concepts used in epidemiology and how rates are calculated;
- Level 5(5): Interpret data on health and wellbeing within own area of expertise or practice;
- Level 6(d): Understanding of links between, and relative importance of, the various determinants of health and wellbeing and needs;
- Level 7(1): Assess and describe the health and wellbeing and needs of specific populations and the inequities in health and wellbeing experienced by populations, communities and groups.

This chapter will also assist you in demonstrating the following National Occupational Standard for public health:

- Collect and link data and information about the health and wellbeing and related needs of a defined population (PHP10).

This chapter will also be useful in demonstrating Standard 6 of the Public Health Practitioner Standards.

Standard 6

Obtain, verify, analyse and interpret data and/or information to improve the health and wellbeing outcomes of a population/community/group – demonstrating:

- b. knowledge of the main terms and concepts used in epidemiology and the routinely used methods for analysing quantitative and qualitative data.

Overview

This chapter will help you to understand links between, and relative importance of, the various determinants of health and wellbeing and need. It will also give you an understanding of basic terms and concepts used in epidemiology and how rates are calculated.

After reading this chapter you will be able to:

- define health and wellbeing, and needs assessment;
- understand that there are links between social determinants and health;
- describe what is involved in a joint strategic needs assessment (JSNA);
- define some key epidemiological and health economics concepts.

Introduction

One of the most important tasks we have as a society is to promote the health and wellbeing of our population, looking to improve their long-term quality of life. To do this we must have a good understanding of the needs of that population, whether children and young people, younger or older adults.

It is not just about 'data'. We also must involve people in a meaningful dialogue about their perceptions of need. It has been said that:

experts and professionals can put their own interest before the wellbeing of their clients and research subjects. Often too they will be so ignorant of the reality of life for ordinary people that their proposals can be counter productive or just plain stupid.

(Gough, 1992)

So we need to answer three basic questions. What is health and wellbeing? What determines health and wellbeing? What is need? We will answer the second question in discussing need and need assessment.

In addition, in this chapter we will review basic epidemiological and health economics principles and concepts so that you can assess the usefulness of all the available data.

What is health and wellbeing?

The World Health Organization (WHO) defined *health* as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity (WHO, 1948).

In 1986 this definition was revised for the *Ottawa Charter for Health Promotion*: *health* is seen as a resource for everyday life, not an object of living. It is a positive concept emphasising social and personal resources as well as physical capabilities – the extent to which an individual or group of individuals is able, on the one hand, to realise aspirations and satisfy needs, and on the other hand to change or cope with the environment (WHO, 1986).

Wellbeing is a term that is used increasingly in UK government policy. This may be to distinguish between the responsibilities of the health service and the wider joined-up approach to improving the status of the population. It is included in the original WHO definition to indicate much more than just a state of physical health. It also encompasses emotional stability, clear thinking, the ability to love, create,

embrace change, exercise intuition and experience a continuing sense of spirituality. However wellbeing is defined in many ways in different contexts.

It has been suggested that the first and most important way to make sense of how *wellbeing* is used in contemporary policy is this: wellbeing is a *social construct*. There are no uncontested biological, spiritual, social, economic or any other kind of markers for wellbeing. The meaning of wellbeing is not fixed – it cannot be. It is a *primary cultural judgement*; just like *what makes a good life?* (Ereaut and Whiting, 2008).

What is need and needs assessment?

Need, in terms of healthcare, has been defined as the population's ability to benefit from health (and social) care interventions (Stevens and Raftery, 1994). Chapter 3 discusses needs assessment in more detail.

There are many models for the assessment of need in a population and health needs in particular. In this book, two approaches are recognised. The first approach starts with information gathered from different sources – these may be routine data from health surveillance, or local service use or applied rates from epidemiological studies in other populations – to identify aspects which are important or unusual in that population. In contrast, the second approach starts with a theoretical model which identifies the main factors that determine health and describes the local picture in the light of this. Both approaches will make use of the same sources of information (see Chapter 2 on measures of health) but the second aims to present the information in a way that illustrates the public health model. Taking this approach to assessment of need, there are two key models that have credibility and are mutually complementary: these are the life course and social determinants models.

The first is based on *life course theory*. Life course theories were developed to explain observations such as the way that the health of adults is influenced significantly by what they experienced during development both in the mother's womb and in their early years. The framework is described in a report entitled *Childhood Disadvantage and Adult Health: A Lifecourse Framework* (Graham and Power, 2004).

What's the evidence?

The *life course framework* provides an explanation for the persistence and worsening of inequalities by describing the ways in which health is transmitted from generation to generation. In the preface to the report (Graham and Power, 2004, pv), Kelly (then Director at the Health Development Agency) states that it is

through economic, social and developmental processes, and the advantages and disadvantages are reinforced in adult life. A 'life-course approach' focuses on the different elements of the experience of health, from the moment of conception through childhood and adolescence to adulthood and old age.

There is very good evidence underpinning the importance and positive long-term outcomes of promoting early child development, through a range of services and interventions. The body of knowledge built up through longitudinal studies, based on life course theory, and informed by the understanding of developmental neurology (how the brain develops, for example) should be the basis of needs assessment.

The determinants of physical health and health behaviour are summed up in the preface to the report. Kelly goes on to say:

disadvantaged childhood conditions have a direct impact on child health. So children from poorer circumstances tend to be affected in a number of ways: slower foetal growth, lower birth weight, shorter height and leg length, and more disease. Adolescence is critical in determining behaviour such as cigarette consumption, dietary behaviour, exercise and alcohol use, and while there is much evidence to show that children from all social groups tend to experiment with smoking and alcohol as well as drugs, the potentially damaging long-term use of drugs and alcohol, as well as consumption of fat, sugar and salt, are established in adolescence.

(Graham and Power, 2004, pvi)

An example of the evidence to support this approach comes from the Northern Swedish Cohort Study (Gustafsson *et al.*, 2011). This study is a prospective cohort study comprising all adolescents who entered or should have entered the ninth (last) grade of compulsory school in 1981 in a Swedish town. The influence of socioeconomic status (SES) on health over the life course is complex. Contrasting findings suggest that the enduring effect of childhood SES on adult body mass is largely independent of adult social class. This is known as the sensitive (or critical) period life course model, which suggests that exposure during particular periods of life (e.g. childhood/adolescence) results in long-term health effects, independently of later exposure. To understand the mediating factors and to determine how far this is true, a cohort study is the best method.

The Swedish study examined whether body mass index (BMI) at the age of 16, 21, 30 and 43 years, and 27-year BMI change, are explained by past and present socioeconomic disadvantage in women (and men), and if the SES–body mass association is explained by health behaviours. The results showed that, in women but not in men, associations between SES and body mass across the life course correspond to both the cumulative risk (persistently living in low SES) and sensitive period (in adolescence) models, and that health behaviours do not seem to mediate this association.

This important finding has implications: that to reduce social inequality in obesity in women, efforts should be directed at the early life course and not limited to targeting unhealthy behaviours.

However it is not only physical health but also social wellbeing which is explained by the life course framework. There are several ways in which this may be seen to work, and a model relating to social health is shown in Figure 1.1.

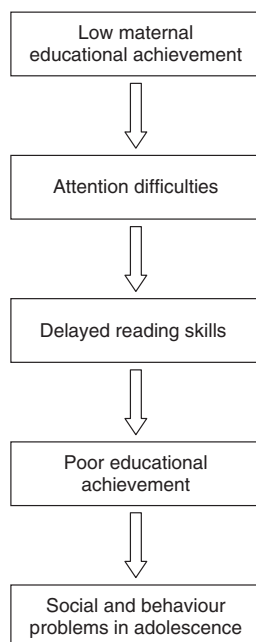


Figure 1.1 Model of social health

This model is drawn from cohort studies (Wickrama *et al.*, 2003) which show that, when a mother has a low educational achievement level, there is an increased likelihood that her child will show attention difficulties leading to delayed reading skills. This contributes to poor educational achievement by the child and this is associated with a higher risk of social and behavioural problems in adolescence.

Wickrama *et al.* (2003) illustrate this life course experience, showing how a combination of social disadvantage in the family of origin and adolescent maladjustment increases risk for physical health difficulties during adulthood. The results showed that early risk factors initiate a sequence of negative influences on young adult physical health through early entry into family responsibility, truncated educational attainment and poor occupational and economic status. These associations prevailed even after controlling for physical health status during adolescence.

The second model describes the influences on health and wellbeing – often called the social determinants of health – as the conditions in which people are born, grow, live, work and age. These conditions combine to influence wellbeing and are dependent on the quality of housing, education, employment and, for example, a nurturing environment in childhood. The negative influences associated with poverty are twofold:

1. People living in poverty are more likely to be exposed to conditions that are adverse to their health (crowded living conditions, unsafe neighbourhoods).
2. People living in poor circumstances are more likely to be negatively affected by these adverse conditions.

These influences have been described recently in the global examination of the social determinants of health (WHO, 2008a). Inequities in health are related to social and

economic policies that lead generally to better health for those with higher incomes and better education. Once societies reach the level of affluence found in developed countries, further improvements in absolute standards make little difference to improving health. Differences in health at that stage begin to reflect differences in income distribution or income inequality, sometimes known as relative poverty, within each country. However the Commission on Social Determinants of Health emphasised a number of core influences at neighbourhood or community level:

- early child development and education;
- healthy places;
- fair employment;
- social protection;
- universal healthcare.

What's the evidence?

Social determinants of health: the solid facts

There are gross inequalities in health between countries. Life expectancy at birth, to take one measure, ranges from 34 years in Sierra Leone to 81.9 years in Japan. Within countries, too, there are large inequalities – a 20-year gap in life expectancy between the most and least advantaged populations in the USA, for example (Marmot, 2005). A boy born and living in Manchester will have 7 years' less life expectancy than a boy born and living in Surrey (APHO, 2010a).

Because the causes of the causes are not obvious, the WHO commissioned a summary of the evidence on the social determinants of health. This was published as *The Solid Facts* (Wilkinson and Marmot, 2003). It had ten messages on the social determinants of health based on:

1. the social gradient;
2. stress;
3. early life;
4. social exclusion;
5. work;
6. unemployment;
7. social support;
8. addiction;
9. food;
10. transport.

The Solid Facts reviewed evidence from Europe, aimed mainly at reducing inequalities in health within countries. The Commission on the Social Determinants of Health (WHO, 2008a) reviewed evidence on the social determinants of health that are relevant to global health and health inequalities.

One recognised illustrative picture of the interrelationships of the social determinants of health is shown in Figure 1.2 (see also Chapter 4 in the book *Leading for Health and Wellbeing* in this series). This picture (also known as Dahlgren and Whitehead's social model of health) makes clear the wide range of determinants that influence health. Age, gender and genetic constitution are at the centre. These inevitably influence people's health potential but are fixed. The next layer is related to individual lifestyle factors and ways of living that have the potential to promote or damage health. The third layer is social and community influences and networks. These can provide mutual support for members of the community but they can also provide no support or have a negative effect. The fourth layer focuses on general socioeconomic, cultural and environmental influences. These include structural factors such as housing, working conditions, agriculture and food production, access to services and provision of essential facilities.

Many of the *causes of the causes* of poor health and wellbeing, which probably account for 80 per cent of improvement in life expectancy, can be influenced locally, mainly through the local agencies acting in partnership.

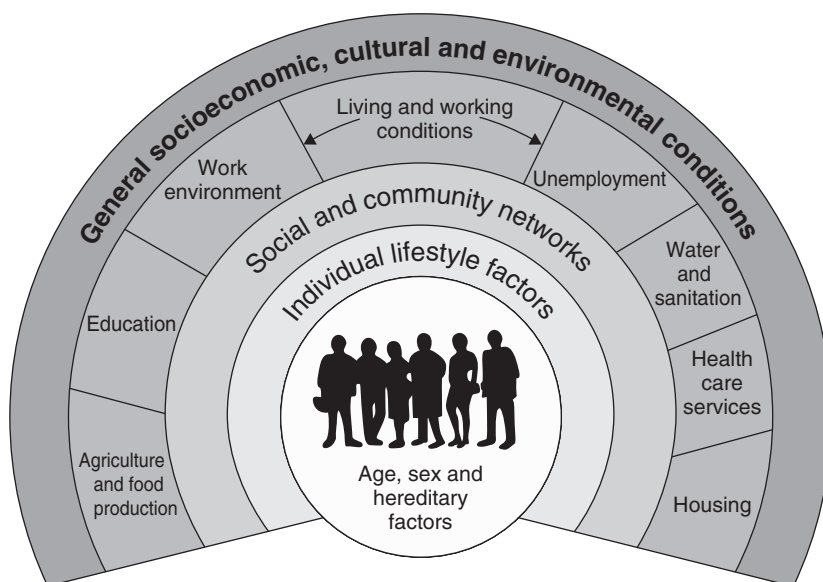


Figure 1.2 Wider determinants of health

Source: Dahlgren and Whitehead, 1991. Reproduced with permission from Institute for Futures Studies, Stockholm, Sweden.

Most determinants are included as domains in the Index of Multiple Deprivation (IMD) and nearly all indicators of health and wellbeing are predicted by this index (see Chapter 2). The IMD is a national measure of deprivation used in the UK.

ACTIVITY 1.1

Looking at the model of the determinants of health in Figure 1.2, what are the top five factors that have a negative impact on your community? What five factors have a positive effect on your community? Now look at the report published by the Marmot Review Team in 2010, *Fair Society, Healthy Lives* (access at: www.marmotreview.org) – does that change your selection?

Comment

In this exercise you are being asked to think about what you know about your community, which could be where you live or in public health terms the population whose health you work to improve. You might have identified employment as one of the key determinants that has a positive or negative effect. For example, if there has been a big change in the local economy such as the demise of an industry providing lots of jobs, then you would see redundancy and unemployment as a negative effect. On the other hand, if there was a new enterprise employing young people and school leavers, reducing the proportion of people aged 16–25 who are not in work or training, then this would be identified as a positive impact.

Taking another determinant, you might point to lifestyle factors such as binge drinking as a particular problem.

The Marmot Review will help identify factors which contribute positively to the life course and to reducing inequity. These may be the same – employment is a consistent theme, for example. However you may want to place emphasis on other themes. You would not select, say, some of the health-related indicators as factors but rather be clear about those causes of ill health which are important locally.

As needs assessment includes the ability to benefit from health (and social) care interventions, there has to be a process which identifies relative priorities for investment, as resources are not available to meet every need.

Priority frameworks set out the criteria to be used to rank different options for improving health and wellbeing. They focus on a number of concepts, such as:

- health outcome (how much benefit will this give to the individual?);
- health impact (how much benefit will this bring across the population?);
- clinical effectiveness (what is the probability of getting the desired effect?);
- cost-effectiveness (what does it cost to gain a quality-adjusted year of life?);
- evidence (how good is the evidence?);
- equity/non-discrimination (does it address inequity in provision or access?);
- access (does it improve access to the population as a whole?);
- autonomy/patient choice (does it allow or increase patient choice?).

Prioritisation and these frameworks are discussed in more detail in Chapter 6.

What is a joint strategic needs assessment?

Joint strategic needs assessments (JSNAs) were introduced by the government in 2006 in a document called *The Commissioning Framework for Health and Wellbeing* (DoH, 2007a, Appendix A, p64). The Local Government and Public Involvement in Health Act 2007 subsequently required local authorities and primary care trusts (PCTs), from 1 April 2008, to work together to produce a JSNA, focusing on the health and wellbeing of their local community. It is defined as:

'a process that identifies current and future health and wellbeing needs in light of existing services, and informs future service planning taking into account the evidence of effectiveness'. JSNA identifies 'the big picture' in terms of the health and wellbeing needs and inequalities of a local population.

(DoH, 2007b, p7)

When the JSNAs were first required, they were meant to feed into a number of important local strategies and plans. These included:

- the Sustainable Community Strategy (SCS), informing the priorities and targets set by the Local Area Agreement, which is the delivery agreement for the SCS;
- the Children and Young People's Plan of the local children's trust;
- the Commissioning Strategic Plan of the PCT.

The JSNA should identify priorities for commissioners, including general practitioners or clinical commissioners, to help to specify desired outcomes, and help providers shape services to address needs. Commissioning decisions informed by the JSNA should lead to improved health and wellbeing and reduced inequalities at best value for all (Figure 1.3). An important aspect of the assessment would be to predict levels of need 3–5 years ahead.

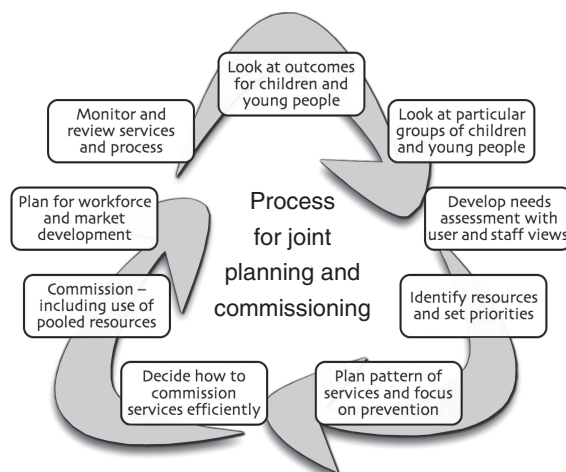


Figure 1.3 The place of a joint strategic needs assessment within the commissioning cycle

Source: Department for Children, Schools and Families and Department of Health, 2009. Reproduced under the terms of the Crown Copyright PSI Licence C2010000141.

A JSNA provides basic information about the needs of the population and should contain as wide a range of information as possible, whether addressing the needs of the whole population or the needs of a particular group, such as children and young people. What you should find is that the authors have used the most recent information available, and will have commonly used rates or trends (such as the annual rates shown over several years) to draw comparisons. These comparisons may be:

- within the area (comparing electoral wards, for example);
- with similar areas;
- with the national rate;
- with international rates.

What's the evidence?

The duty to produce a JSNA (HM Government, 2008)

Section 116 of the Sustainable Communities Act 2007 introduced the requirement for PCTs and responsible local authorities to produce a JSNA of the health and social care needs of their local community. It was envisaged that this assessment should set out the future health and social care needs of the local population. The assessment should cover those issues where the responsibilities of the PCTs and local authorities overlap, or where one organisation in carrying out its functions impacts to a significant extent on the other organisation's functions.

JSNAs consider the needs of the population living within the boundaries of the upper-tier local authority or unitary council. In two-tier local authority areas, upper-tier local authorities are required to consult with those district councils within their geographical area. In order to provide a firm link between the results of the JSNA and the SCS of each local authority, PCTs within a local authority's geographical boundary feed into a single assessment.

This guidance was superseded by new guidance from the Department of Health (2011a), giving Health and Wellbeing boards the primary responsibility for producing the JSNA. Recent draft guidance and current consultation propose, from April 2013, giving Health and Wellbeing boards the primary responsibility for producing the JSNA and joint health and wellbeing strategies (JHWSs), the strategies for meeting the needs identified in the JSNA. Local authorities, together with clinical commissioning groups, will have an equal and joint responsibility for producing the JSNA and JHWS. The local board is envisaged as the means for local government to work in partnership with commissioning groups to produce comprehensive JSNAs leading to the development of joint health and wellbeing strategies (Figure 1.4). These strategies therefore form the local framework for commissioning, including wider-ranging local interventions to address the determinants of health and wellbeing.

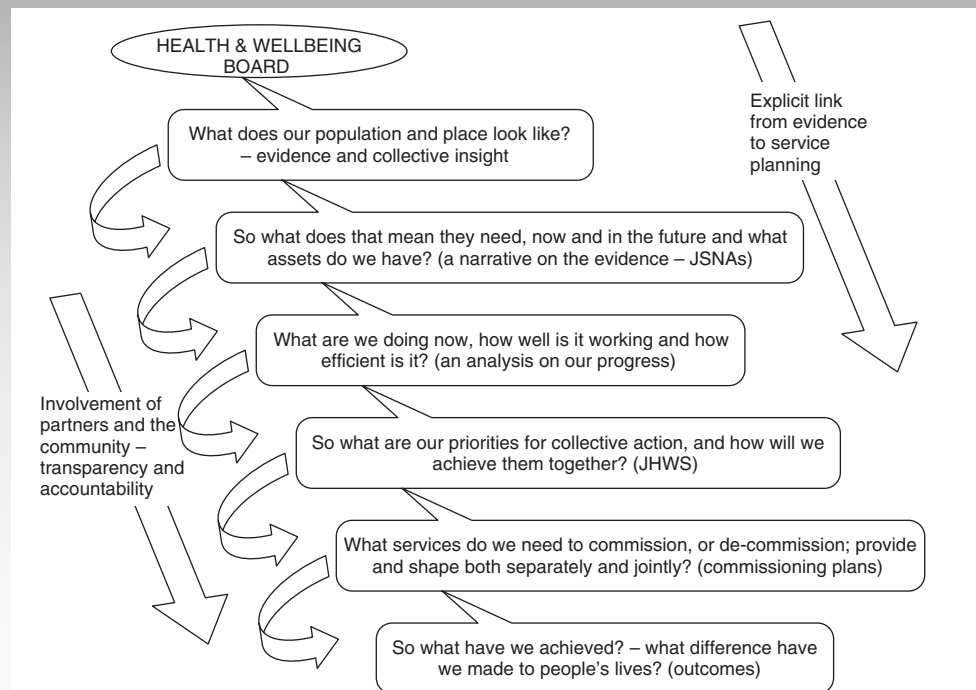


Figure 1.4 How joint strategic need assessments (JSNAs), joint health and wellbeing strategies (JHWSs) and commissioning plans fit together

Source: Department of Health (2012). Reproduced under the terms of the Crown Copyright PSI Licence C2010000141.

The draft guidance (Department of Health, 2012) emphasises the point that use of JSNAs is much more than simply a legal duty. Rather, it should be seen as an opportunity to develop the strategic framework to tackle need and inequalities in health and wellbeing at a local level. The new national emphasis is on improving life chances and outcomes for local communities, especially for people in the most vulnerable circumstances.

To do this it is expected that the JSNA will consider all current and future health and social care needs in relation to the area of the responsible authority. The guidance defines need as those factors (needs) which are capable of being met, or affected to a significant extent, by the local authority, clinical commissioning group or NHS Commissioning Board functions. This is in the context of preparing enhanced JSNAs, which must involve people living or working in the area.

Case Study: Key points from a joint strategic needs assessment

This box highlights some key points from the JSNA in a London borough about the local determinants of health.

Housing

- People aged 65 and over in the borough are more likely to be in accommodation with no central heating (22.3 per cent) than those in England (9.78 per cent).
- 53.6 per cent of council dwellings fell below the decent home standard, compared with 32.3 per cent for London and 26.2 per cent for England.
- Housing markers of poverty (homelessness, no central heating) are higher in the borough; this is especially noticeable among people aged 65 and over.
- 16 per cent of households are overcrowded. At 1 April 2009, the borough had a total of 6,154 overcrowded households wanting to be rehoused, of which 51 per cent were categorised as being severely overcrowded.¹

Safety and crime

- Notifiable offence rates mirror geographic trends for deprivation, where the southern (132) and central (144) parts of the borough have higher rates per 1,000 population compared with the northern part (100). Youth gangs follow the same geographical pattern.
- Violent crime in the borough is above the England average. The level of the population exposed to violent crime is higher (3.7 per cent) than for England (1.4 per cent).
- Domestic violence rates in the borough are the 11th highest in the Metropolitan police service.
- One-third of notifiable offences in the borough were committed by young people under 19 years; reported crimes for children aged 10–17 are above the average for England.

Education

- Completed education attainment influences an adult's ability to provide for his/her family.

1 Occupancy rating of –2 or less (shortfall of bedrooms required for numbers in house).

Of the total population of the borough:

- 28.5 per cent have no educational or skills qualification;
- 41.5 per cent have level 1–3 qualifications;
- 24 per cent have a qualification of level 4/5;
- current levels of academic achievement are similar to those for England.

Key point

Higher educational attainment is linked to many beneficial behaviours and good health outcomes. Education offers opportunities for significant improvements in life expectancy and inequalities. While increases in education will take years to have an impact, the impact will affect people's lives for years.

ACTIVITY 1.2

Health profiles for local authorities are produced annually by the Association of Public Health Observatories (funded by the Department of Health). Find the profile for your population (accessed at www.apho.org.uk).

What does it tell you about the determinants of health?

Does the profile identify any particular need that you would want to highlight (remember – is there the ability to benefit?)

Prepare a summary of 100 words to present to your local Health and Wellbeing board.

Comment

The guidance defines need as those factors (needs) which are capable of being met, or affected to a significant extent, by commissioners. In this case you will want to present something giving one or two priorities which can be positively affected by the actions of the Health and Wellbeing board, collectively or through individual partners.

If one of the key issues is the levels of domestic violence (see case study above), you would explain briefly why it is a local priority, what might be contributing to the problem and what interventions could be put in place.

The core dataset

The case study shows a variety of information about housing, safety and education. Previous guidance from the Department of Health included the publication of a JSNA core dataset in 2008 to aid local authorities and PCTs in the process. This

national dataset proposes use of approximately 250 key indicators, including 68 top-level measures, which can be used to compare one area with others. Indicators or measures like these are discussed in the next chapter.

The core dataset provides an indicative list of indicators to assist partnerships in preparing their JSNA in several domains. Further information on each indicator is provided either within the guidance or in the official *Handbook of Definitions* for the national indicator set. This was updated in April 2009 (see www.yhpho.org.uk) and the core dataset now contains additional national indicators and vital signs (the NHS equivalent).

The indicators are divided into *domains* and *sub-domains*. These are not official categories. The domains include demography, social and environmental context and burden of ill health. The 'demography' domain underpins the JSNA, both by setting local context and as an essential component in producing projections and breakdowns of need. The remaining domains, sub-domains (and sub-sub-domains) contain indicators which either measure need or are a proxy for it. Some of them relate to a particular age group. Many are related to factors such as housing and employment; on the other hand, some are disease-specific.

There are many sources of data. Here are the websites for various sources which are referred to in Chapter 2, where we describe specific measures.

- Office for National Statistics (www.statistics.gov.uk);
- Hospital Episode Statistics (<http://www.hesonline.nhs.uk>);
- Association of Public Health Observatories (www.apho.org.uk);
- Communicable diseases (www.hpa.org.uk);
- Quality Management and Analysis System (www.pcc.nhs.uk/qmas);
- National Cancer Intelligence Network (www.ncin.org.uk);
- Clinical and Health Outcomes Knowledge Base (<http://nchod.uhce.ox.ac.uk/>);
- Prescribing data (www.ic.nhs.uk/statistics-and-data-collections/primary-care/prescriptions);
- Mental Health Profiles (www.erpho.org.uk/pub/mhp09.aspx);
- Compendium of Clinical and Health Indicators (<http://indicators.ic.nhs.uk>).

Addressing inequalities

The JSNA should focus upon the inequalities in the local area, and identify those groups which are getting a 'raw deal'. Demographic indicators which could provide a useful breakdown for the study of inequality in other indicators are marked in the dataset. For instance, a particular need may be higher or lower in certain age groups or ethnic groups, among disabled people or in deprived areas.

Methods of analysing and expressing inequalities in health and wellbeing are

described in part 5 of JSNA – the APHO Resource Pack, Measuring Health Inequalities (APHO, 2008). The challenge of reducing inequalities is addressed in Chapter 6.

The next section in this chapter will consider some of the key epidemiological concepts used in measuring health and wellbeing.

Key epidemiological concepts

This is not an epidemiological textbook, but epidemiology underpins our knowledge of the models of the determinants of health and wellbeing, and will help answer some important questions. Understanding some key concepts will help make sense of the abundance of data which is available.

Epidemiology is the study of the natural history of disease in a population. It seeks to understand the causes, distribution and control of disease in populations.

A *causative agent* may cause disease by its presence (e.g. common cold virus) or absence (e.g. lack of vitamin D). Broadly, epidemiologists look at the relationship between aspects of the total environment in which individuals live and outcomes over time. Those environmental factors include the physical environment, the socio-economic context and/or the biological influences. It is possible to measure the impact of these factors on susceptible or 'at-risk' individuals and groups and predict a level of risk in respect of the probability of developing a specific condition, or probability of death.

Distribution requires some measure of frequency – how often and how many cases in the population. An important principle is that epidemiology is looking at disease outcomes in a specified population – the population at risk.

The classical types of study are descriptive – cross-sectional, cohort or case-control studies; or interventional – a clinical or community trial.

A *cross-sectional* study examines the relationship between diseases or other aspects of health and variables such as exposure to risk factors in a defined population at one particular time.

A *cohort* study examines multiple health effects (positive or negative) of an exposure. An exposure may be a social or environmental factor, or a lifestyle factor. Subjects are followed over time and analysis is defined according to their exposure levels and future occurrence of disease or other health effects. A cohort study will define disease incidence because you can count how many specific events (such as people being diagnosed with diabetes) occur in the cohort each year.

A *case-control* study examines multiple exposures in relation to a disease or particular condition. Those subjects with the condition are defined as cases and then matched with controls who do not have the condition. Matching is usually done on age and gender and exposure histories of cases and controls are then obtained and compared.

An *interventional* or *experimental* study, also known as a trial, investigates the role of some agent in the prevention or treatment of a disease. In this type of study, individuals are assigned to two or more groups that either receive or do not receive the intervention, i.e. an intervention group and a comparison group.

An *ecological* study is an epidemiological study in which the unit of analysis is

a population rather than an individual. For instance, an ecological study may look at the association between smoking and lung cancer deaths in different countries.

Bias is a systematic tendency to over- or under-estimate the number of cases or events. This may occur for different reasons. The individuals or populations studied (or responding) may not be representative of the population, the information source may be incomplete (e.g. because some cases have not been notified) and the measurement used may be inconsistent. Much of our information comes from counting events, which are measured for strategic (often mandatory) purposes or operational reasons and we need to be aware of the limitations.

Other key terms used in epidemiology are incidence and prevalence. *Incidence* is the rate at which new cases (or events) occur in a population in a specified period. For example, incidence of bowel cancer is the number of new cases of bowel cancer which occur in a year for every 100,000 of the population.

Prevalence is the proportion of the population who are cases at a point in time. This could be the percentage of people who smoke, or the percentage of people who have ever been diagnosed with diabetes.

In order to ensure consistency, and enable comparison, the *case* must be clearly defined. For example, if we want to know the prevalence of asthma in children then counting those who have been given a diagnostic label of asthma may miss children who have symptoms which are characteristic (such as waking at night with wheezing) but who are not labelled as asthmatic.

The number of cases determines the nominator in calculating *rates*, i.e. the number to be divided by the number in the population at risk, or the denominator. The denominator is the lower part of a fraction used to calculate a rate or ratio; in a rate, the denominator is usually the population, or population experience, as in person-years, at risk. Care needs to be taken to ensure the nominator is related to the appropriate 'at-risk' population.

Incidence and prevalence are common types of rates, as are mortality rates, which are usually expressed as rates for a specific disease or group of conditions. A simple calculation will produce what is called a *crude rate*. For example, if there are 2,000 deaths from all causes in a population of 200,000, the crude mortality rate is 10 per 1,000. Rates may be refined to make them more relevant or to be able to use them to make comparisons.

An overall rate for the population may disguise the fact that the incidence varies with age. For many conditions (e.g. cataracts) the incidence rises with age, so age-specific rates are helpful in planning and assessing change over time as the age structure of the population changes. These rates may also be better examined by gender.

To adjust rates to allow comparison between rates for different populations, the technique known as *standardisation* is used. The aim is to reduce the confounding factors such as age, gender and SES. Age is the common basis of standardisation.

There are two main standardisation methods, characterised by whether the standard used is a population distribution (direct method) or a set of specific rates (indirect method). The direct method is used to calculate a *standardised rate*, which can be compared properly with the standardised *rate* for another population. A common use in England is the standardised hospital admission rate for different conditions.

The indirect method is used to calculate a standardised *ratio*, so the frequency of events in the population is effectively compared to the standard population. The *standardised mortality ratio* (SMR) is calculated by dividing the total of observed deaths by the total of expected deaths. The number of expected deaths is calculated by applying age-specific rates for the standard population to the target population age groups. If it is greater than 1 (or 100 if expressed as a percentage), it indicates that the risk of dying in the observed population is higher than what would be expected if it had the same experience or risk as the standard population. On the other hand, a SMR lower than 1 (or 100) indicates that the risk of dying is lower in the observed population than expected if its distribution were the same as the reference population.

In the following case studies we are going to calculate age-standardised rates and SMRs.

Case Study: Calculating standardised mortality ratios

Directly age-standardised rate for deaths from all circulatory diseases (ICD10 I00–I99, ICD9 390–459)² for males aged under 75 years

Stage 1: Calculate the age-specific rates in area A

You need to know two things – the number of events (deaths) by age group in area A for a given year (or over a number of years, e.g. a 3-year average). The narrower the age group the better. Five-year age bands are suggested here. The second set of data you need are the numbers of the population in each age group in area A. Now divide the number of deaths (row a) by the population (row b), and multiply by 100,000 to calculate the age-specific rate.

	Sex	0–1	1–4	5–9	...	65–69	70–74
a. Observed events (deaths)	M	0	0	0	...	50	70
b. Population	M	2,200	9,300	11,900	...	5,800	4,700
c. Age-specific rates per 100,000 ((a/b) × 100,000)	M	0.0	0.0	0.0	...	862	1489

2 The *International Classification of Disease* (ICD) has had many revisions. The commonly used version in the UK is ICD10, but ICD9 is still in use in some information systems.

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Stage 2: Calculate the expected number of events (deaths) in the standard population, given the age-specific rate in area A

The standard European population is a fixed standard with numbers of population by age group and by gender. These numbers go in row d. The age-specific rates for area A are now put in row e. These rates are expressed as numbers per 100,000, but to be applied will have to be divided by 100,000. (The rates could have been left as decimal rates, e.g. 0.01489 for the 70–74 age group.) This calculation gives you the number of expected deaths per age group (row f).

Age group	0	1–4	5–9	...	65–69	70–74
d. Standard population (European standard population) by age group	1,600	6,400	7,000	...	4,000	3,000
e. Age-specific rates of area A	0.0	0.0	0.0	...	862	1,489
f. Expected number of events (deaths) in the standard population ((e) × (d))/100,000)	0.00	0.00	0.00	...	34	45

Stage 3: Calculate the age-standardised annual rate

Add up the total expected events across all appropriate age groups (row f) to give a total number of expected events for the year selected (column aa). Add up the standard population across all the selected age groups (row d) and put the total in column bb. Divide the total expected events (aa) by the total standard population (bb) and multiply by 100,000 to give the age-standardised rate. Note that the total used here (column aa) is illustrative rather than actual.

aa. Total expected deaths 0–74 years	bb. Total standard population 0–74 years	Standardised rate 0–74 years
140	96,000	145.83

i.e. in area A the directly standardised rate for deaths from circulatory disease in males in that year was 146 per 100,000.

Case Study: Calculating standardised mortality ratios

Indirectly standardised rates compare the actual number of events in an area (e.g. South Gloucestershire) with the expected number of events based on mortality rates of a reference population (e.g. England and Wales).

This method is often used to look at differences in mortality rates, and is often referred to as the standardised mortality ratio (SMR). The SMR is a ratio of observed to expected number of deaths. It can also be used to look at other events, such as hospital activity, e.g. standardised admission rates. The observed figures come from the local area, and the expected figures from applying the death rate in the reference population to the local population.

Example

In this example we are comparing mortality in people aged 64 and younger in area A to mortality in England and Wales for the same age range. The actual number of deaths in area A was 560. The following steps are used to calculate the SMR.

Step 1

Find the age-specific death rates in the reference population, England and Wales, and put in column a. In this example the age bands are wider than in the case study using the direct standardisation method.

Step 2

Find the populations in area A for the same age bands, and put in column b.

Step 3

Calculate the expected deaths in each of the age groups by multiplying the population in area A by death rate in the reference population (England and Wales) and dividing by 100,000, i.e. expected deaths per 100,000 = $(b \times c)/100,000$.

The table below shows the calculation of steps 1–3.

Step 1	Step 2	Step 3	
a	b	c	d
Age groups	Deaths per 100,000 in England and Wales	Population in area A	Expected deaths per 100,000
15–24	31	60,000	18.6
25–34	45	64,000	28.8
35–44	84	63,000	52.9
45–54	120	69,000	82.8
55–64	554	58,000	321.3

Step 4

Add up the number of deaths in each age group (column d) to get the total number of expected deaths. This total is 504.

Step 5

The SMR can now be calculated. It is the observed number of deaths/expected number of deaths expressed as a percentage.

In this example, the SMR is $(560/504) \times 100 = 111$.

When looking for comparisons to make a judgement about the relative importance of a rate, standardised ratios provide the comparison by reference to the standard population. Often it is the national rate which is used as the standard. Similarly, rates may be compared to a regional average, or an average for populations, which are treated as a cluster because they have similar characteristics (such as inner city or rural). The difficulty here is that the usual or average is not necessarily good and having a better (or worse) rate than average may divert attention from an unacceptably low or high value. Similarly, use of distributions of values and asking which percentile (often quintiles, i.e. every 20 per cent of the values) a given population comes into, may lead to false assumptions. Where possible it is good to have a true benchmark, set by either evidence or international agreement on excellence.

ACTIVITY 1.3

This activity gives you some real data to use to work through the methodology for standardisation. Go to the website for the Office for National Statistics (www.ons.gov.uk) and search for cancer incidence.

Choose the cancer incidence – results (by year) for Scotland. This will take you to the Information Services Department, NHS Scotland webpage. Download the data tables (in Excel) and you will have a menu of specific cancers or all cancers. Choose

one table and you will find age-specific rates both for Scotland as a whole and for regions. Choose a region, and apply the rates to a standard European population, and compare your answer with the published rate. You can also check the standardised incidence ratio (same method as SMR) for the region compared against Scotland as the standard population.

Comment

There are many sources of data to help you do similar exercises until you are familiar with the method. You may find it helpful to ask a local public health analyst to check your working.

Key health economic concepts

Scarcity

This is where the total resources are not enough to provide for all the interventions which are available to meet the needs of the population, and there are no means of securing additional resources. Scarcity is a fundamental concept, and the need for health economic analysis stems from an understanding of the implications of the notion of scarcity.

Health status

This is the degree to which a person is able to function on a day-by-day basis physically, emotionally and socially. This concept is discussed in more detail in the chapter on outcomes (Chapter 5).

In order to compare the relative value of an intervention aimed at improving health status, some measure is needed which is independent of the specific medical condition and its effects, or the type of intervention. The common approach to this is to use a measure which combines life years gained as a result of health interventions/healthcare programmes with a judgement about the quality of these life years. The *quality-adjusted life year* (QALY) is the commonly used measure.

Quality-adjusted life year

The QALY is a measure of disease burden, which takes account of both how much life is added (the quantity) and how the individual feels about his or her quality of life.

The QALY is based on the number of years of life that would be added by the intervention. A 'utility' value is assigned which ranges from 0.0 to 1.0. Each year in perfect health is assigned the value of 1.0. If the extra years would not be lived in full health, for example if the patient suffered chronic pain, or had severe visual

impairment or had to use a wheelchair, then the extra life years are given a value between 0 and 1 to account for this.

Cost-benefit analysis (CBA)

CBA is an economic evaluation in which all the costs of providing an intervention and the consequences of a programme or intervention are expressed in the same units, usually money. CBA is used to compare costs and benefits across programmes serving different patient groups. Even if some items of resource or benefit cannot be measured in the common unit of account, i.e., money, they should not be excluded from the analysis. Costs would include use of resources beyond the costs falling on the health service alone, e.g. costs falling on other services such as social care or voluntary sector, costs to society such as loss of productivity and costs borne by patients and their carers.

Cost-effectiveness analysis (CEA)

CEA is an economic evaluation in which the costs of alternative interventions are expressed as cost per unit of health outcome, usually measured in QALYs. The incremental cost-effectiveness ratio (ICER) is now used as the first-line method of comparing cost-effectiveness. The results of the cost-effectiveness analysis are expressed by means of the ICER, which is defined as the ratio of the change in costs of a therapeutic intervention (compared to the alternative, such as doing nothing or using the best available alternative treatment) to the change in effects of the intervention. As a formula, for interventions A and B:

$$\text{ICER} = \frac{\text{costs (A)} - \text{costs (B)}}{\text{QALYs (A)} - \text{QALYs (B)}}$$

(Walker *et al.*, 2007)

Opportunity cost

Opportunity cost is the loss of potential gain, such as years of life or quality of life, for one group of the population which is foregone when a commissioner decides to invest in a programme or intervention for another population group. If, for example, a local authority can only afford to fund one of the following – an early years centre, or a centre of excellence for people with dementia – then the opportunity cost of choosing one can be seen to be the loss of the benefit that would have been delivered by the other.

Programme budgeting and marginal analysis (PBMA)

PBMA is a process that helps decision-makers maximise the impact of healthcare resources on the health needs of a local population. Programme budgeting is an

appraisal of past resource allocation in specified programmes, with a view to tracking future resource allocation in those same programmes. The programmes are often categorised by clinical specialities, e.g. diseases of the circulation.

Marginal analysis is the appraisal of the added benefits and added costs of a proposed investment (or the lost benefits and lower costs of a proposed disinvestment) within the programme (Brambleby and Fordham, 2003).

Technical efficiency

Technical efficiency exists when a given level of output can be achieved with a minimal level of input. It is assessed by seeing whether the given output can be achieved by using less of one input while holding all other inputs constant. For example, is it more cost-effective for a consultant dermatologist, say, to go to primary care centres to do a clinic than have patients go to a hospital outpatients department?

Allocative efficiency

Allocative efficiency exists when no change in spending priorities could improve the wellbeing of one population group without reducing the wellbeing of another group.

Chapter summary

This chapter has introduced a number of definitions of health and wellbeing, and the concept of needs assessment. The links between determinants of health and wellbeing and need were considered. In reviewing what is meant by health and wellbeing and need, and need assessment, two frameworks were offered – a life course framework and the social determinants of health model. JSNA was introduced and the significance of the development of a JSNA in improving the health and wellbeing of a population was explored. The importance of a core dataset was emphasised, together with consideration of other sources of data that can be used to assist the preparation of JSNAs. Undertaking a needs assessment is discussed in more detail in Chapter 3.

A number of key epidemiological terms and concepts were introduced, including the calculation of age-standardised mortality ratios and SMRs, as this understanding is fundamental to interpreting the wealth of data available. The chapter concluded with some consideration of the most important health economic concepts.

GOING FURTHER

Coggon, D, Rose, G and Barker, DJP (1997) *Epidemiology for the Uninitiated*, 4th edn. London: BMJ Publishing Group.

This is a very readable guide to the theory, techniques and language of epidemiology.

Glasby, J and Ellins, J (2008) *Implementing Joint Strategic Needs Assessment: Pitfalls, Possibilities and Progress*. Health Services Management Centre, University of Birmingham. Available online at: www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_086130 (accessed 4 August 2012).

This report of a survey of PCTs and local authorities sets out the findings in regard to (then) current approaches, existing data and public and patient involvement. It examines the potential implications of JSNA and offers suggestions for practical support and how JSNAs could be the stimulus for longer-term change.

Napper, M and Newland, J (2002) *Health Economics Information Resources: A Self Study Course*. Available online at: www.nlm.nih.gov/nichsr/edu/healthecon/index.html.

This self-study course comprising four modules describes the scope of health economics and information resources. Drawing on the US healthcare system it focuses on sources and characteristics of healthcare financing information in order to provide an overview and discussion of important sources of health economics information and enable the development of a good understanding of health economic principles.

Orme, J, Powell, J, Taylor, P, Harrison, T and Grey, M (eds) (2003) *Public Health for the 21st Century: New Perspectives on Policy, Participation and Practice*. Maidenhead: McGraw-Hill/Open University Press.

The chapter on epidemiology in the twenty-first century (Chapter 15), although a little demanding, highlights and points to some important ways in which the development of public health practice and epidemiology are interrelated. The chapter on health economics (Chapter 16) provides a more detailed discussion of the concepts outlined in this chapter.