THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

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The DOHaD story: Developmental Origins of Health and Disease

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This slide set is a tool to stimulate discussion and support knowledge development for further inquiry. The slides are accompanied by notes which form the basis for the narrative and offer suggestions for discussion. It is expected that teachers will adapt the use of this resource to suit their learners.

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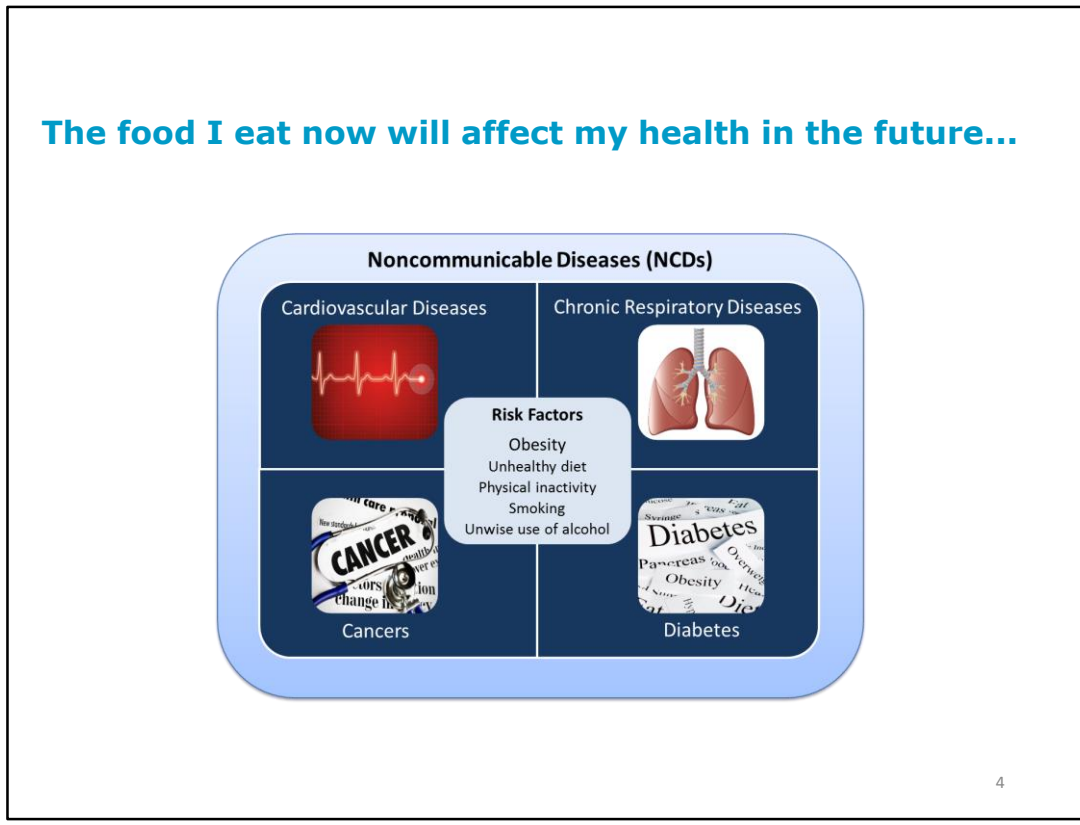


The DOHaD story – Developmental Origins of Health and Disease
What we eat now matters for our own health – why?

Taking a lifecourse approach to health (optimising growth and development at all stages of life) pays a very important part in disease prevention. The healthful habits and behaviours that young people take up now will affect their risk of disease across their life and the risk of disease for future offspring. Young people are becoming more independent and making decisions for themselves, and the habits and behaviours they adopt will have impact. Therefore, it is important to establish healthful habits and behaviours in early adolescence (Baird et al., 2017).

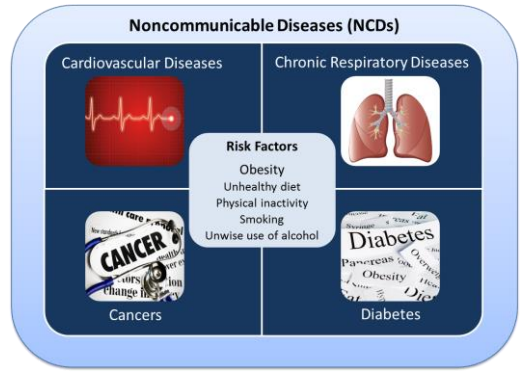
Background information: The foetal and early-life origins of NCD risk and disease (Hertfordshire Cohort Study, n.d.).
https://www.mrc.soton.ac.uk/herts/
Conditions related to overweight and obesity are often presented as a simple linear relationship between energy consumption and expenditure. While the balance between energy consumption and expenditure plays a significant role in obesity outcomes, evolutionary history also contributes to the way in which humans are responding to rapid inter-generational nutritional transition and an increasingly obesogenic environment. The fetal and early-life origins of obesity and NCD risk and disease, or Developmental Origins of Health and Disease (DOHaD) explores and explains the well-established relationship between early-life nutritional environment (before birth) and later life risk of obesity and chronic disease (Gluckman and Hanson 2006). This does not eliminate the impact of unhealthy diet and physical inactivity during adolescence and adulthood on obesity and NCD risk. Rather it adds the now established impact of earl-life nutritional environment into the matrix of factors that contribute towards risk.

A team led by Professor David Barker of the University of Southampton in the 1980s established the initial evidence of the relationship between early-life environment and risk of NCDs in adulthood. An epidemiologist and clinician, Barker observed that those regions of England and Wales that had the highest coronary heart disease (CHD) mortality rates in the 1970's were also the regions that previously had the highest neonatal

mortality rates, which in the early part of the 20th century were most commonly associated with low birth-weight (Barker, 2003).

The search by Barker's team for evidence led them to a large collection of birth and early-life records in the county of Hertfordshire, from which they were able to explore their hypothesis that CHD risk was associated with low birth-weight. The birth-records collected throughout the period by a team of midwives led by Ethel Margaret Burnside included weight at birth and 1-year, method of feeding, smallpox vaccination records and health up to 5-years of age. Tracing the national health records of 15,000 men and women born between 1911 and 1930, the team were able to compare birth-records with health at 60-70 years of age. Of the 15,000 people, 3000 had already died, almost half from CHD or related disorders. A disproportionately high number of those that had died had been low birth-weight babies (Barker, 2003). This ground-breaking study showed that the risk of cardiovascular disease and diabetes increased as birth-weight decreased. Working from this initial hypothesis, it has now been shown that there is an association between early-life nutrition (including under nutrition and high fat-diets during pregnancy as well as under– and excess-nutrition in infancy) and a number of adult-onset conditions including CVD and diabetes.

The food I eat now will affect the health of my children…



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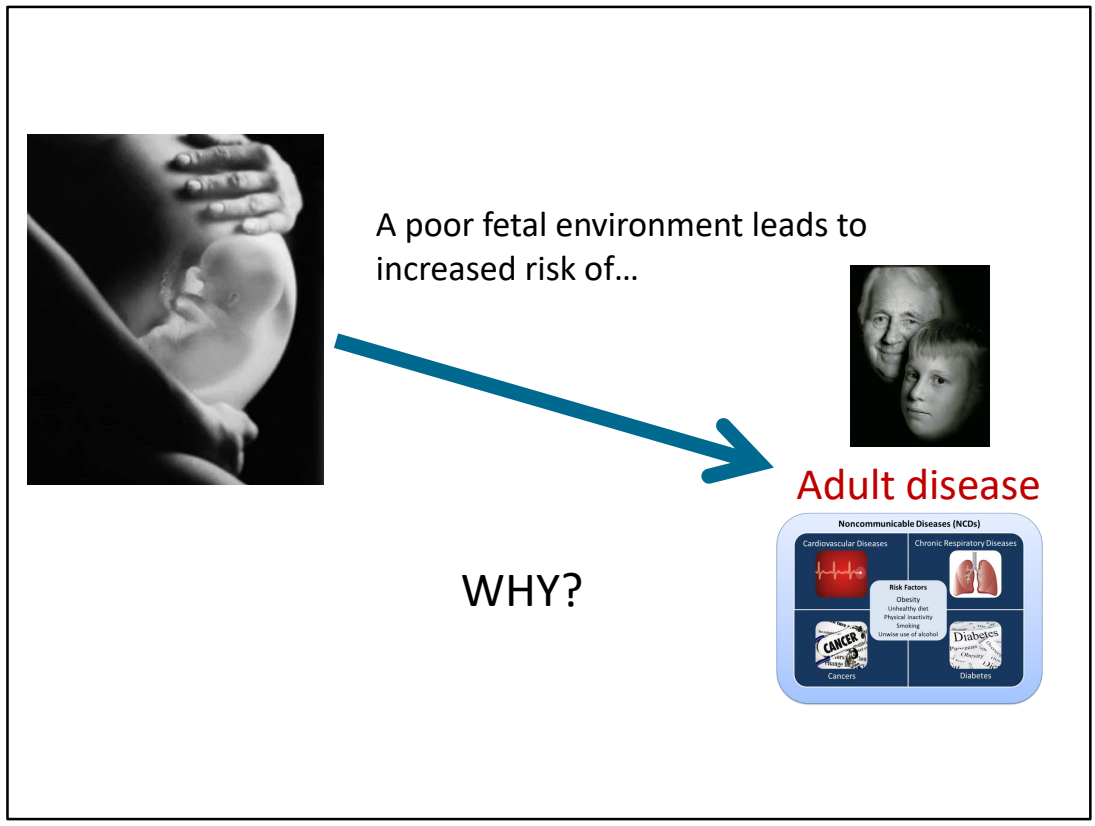
What I eat now **also matters** for the health of any future children.
Discuss – which baby do you think is most likely to develop NCDs in later life?
Medical research scientists are interested in why people get NCDs.
From research, we know that very small babies and very large babies are at greater risk. Small babies – a sign of fetal under-nutrition or macro and micro nutrient deficiencies. High birth weight – mothers with high fat or high energy diets – offspring more likely to develop NCDs later in life e.g. insulin resistance, diabetes, cardiovascular changes (Baird et al., 2017, p. 3).
A mother's nutrition influences not only her health during pregnancy but health of fetus and health of baby later in life. Early life environment – maternal (and paternal) diet can have lasting effects on physiological processes through developmental changes to organs and tissues. And - there is an association between early-life nutrition (what the mother eats while she is pregnant and what the father eats -sperm quality) including under-nutrition and high fat-diets as well as under– and excess-nutrition in infancy (when baby is young) and a number of adult-onset conditions including CVD and diabetes.)



We know that a poor foetal environment leads to increased risk of adult disease - NCDs
The challenge for scientists is to understand WHY – so that new therapies can be developed and also so people understand and are able to act to support their good health
Scientists from around the world are working together to understand how the environment we experience before we are born affects our risk of developing obesity and NCDs such as diabetes and heart disease later in life.
Scientists from the Liggins Institute have shown that a mother's body influences her child's development from the moment of conception.
Her body composition, diet and lifestyle 'teach' her baby about the world in which the mother lives. This will influence the child's risk of disease for the rest of their life.
An early life environment that is either too poor or too rich will increase the RISK of obesity and diseases such as Type 2 diabetes later in life (Godfrey, Gluckman, & Hanson, 2010).

How do we know this?
A OBSERVATION by scientists helped unravel the EVIDENCE that means we now know that our early life environment influences our risk of obesity and diseases like coronary heart disease and Type 2 diabetes (Bay, 2015, p. 9).

For more information see
https://www.mrc.soton.ac.uk/herts/

The Country of Hertfordshire in England

How do we know this?

This is the DOHaD story – which began in the UK–

In the early 1900s, mothers and babies in the UK were less healthy than nowadays – one on ten babies died before they turned one and many were not healthy as they grew older (Hertfordshire Cohort Study., n.d.).

Coronary heart disease: Men, 1968-78

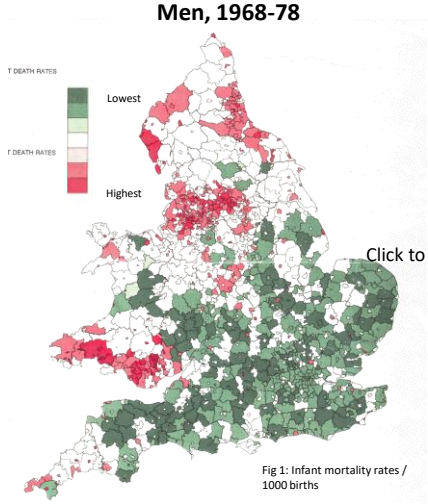


Fig 1: Infant mortality rates / 1000 births

Infant mortality: rate per 1000, 1901-10

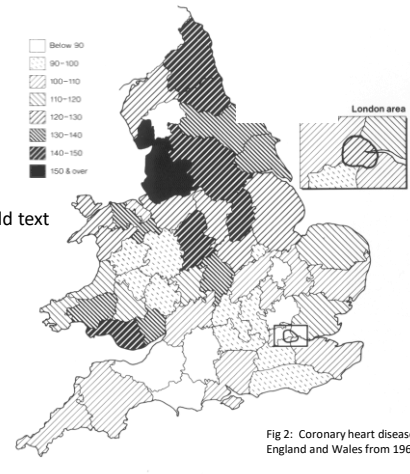


Fig 2: Coronary heart disease in Men in England and Wales from 1968—1978.

Click to add text

In the 1980s – two UK scientists noticed something that parts of the UK which had the least healthy babies around the 1900s had higher rates of heart disease in the 1960s and 1970s.

Look at these two maps of England

Professor David Barker and team noticed that when they compared maps showing infant mortality rates (deaths in children) at the beginning of the 20th century and rates of heart disease in adults in the 1970's - the maps looked remarkably similar.

Did this mean that there was a link between early life environment and heart disease in adults?

This led to the Barker Hypothesis: poor conditions in early life lead to heart disease in adulthood

Professors Barker and the team set about trying to find out whether their hypothesis was correct.

What did they need to know?

What was the hypothesis? (Hypothesis more than a guess – comes from looking at patterns and evidence)

What info would be needed to answer a question like that? Where might that information be found (Bay, 2015)?

The Country of Hertfordshire in England

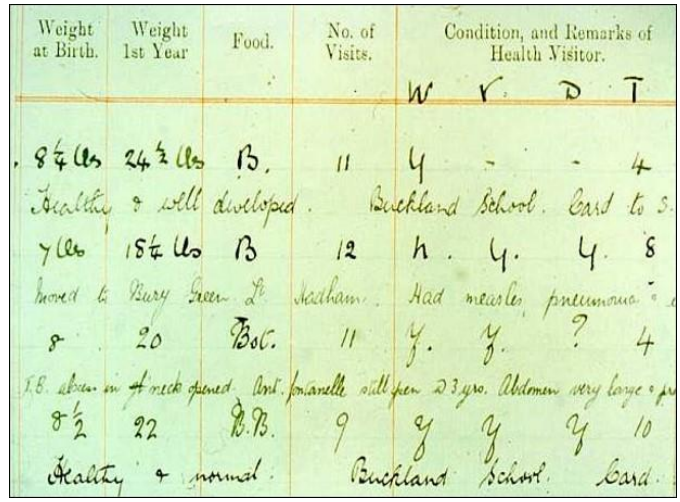
E. Margaret Burnside
Hertfordshire's First Lady Inspector of Midwives.

The scientists needed to find records of birthweight and living conditions from 60 years ago and then link them to current health.
The scientists searched for years to find data from 60-70 years ago – they needed a large set (like collecting all your Grandparents' Plunket records together to compare then to their health now and to look for patterns)
They searched the nations archives (a collection of historical documents or records providing information about a place, institution, or group of people.)
This was difficult – many records were destroyed/not kept. But some had been preserved luckily - in Hertfordshire.
They found birth records from a region called Hertfordshire where from 1911 onwards, a woman by the name of Ethel Margaret Burnside, Hertfordshire's first Lady Inspector of Midwives, had made sure that very accurate records of births and the early years of children's lives were kept by midwives and health visitors (Barker, 2003).

Long version of the DOHaD story:
Prof David Barker (2003) tells the story of how the records were found and how they helped:
Scientists searched for years for data from 60-70 years ago – they needed a large data set.
They searched the nations archives (a collection of historical documents or records providing information about a place, institution, or group of people.)
This was very difficult – many records were destroyed or not kept. But some had been preserved – luckily.
The scientists found a large collection of records of 6 villages in Hertfortshire thanks to a midwife named Ethel Burnside. She was a health visitor and midwife - the first "Chief health visitor and lady inspector of midwives" – she oversaw an army of midwives and nurses who visited families to try to improve the health of children and mothers. For example, they weighed the babies on spring balances (maybe you have used these in science class as force meters?). She biked around the county supervising and encouraging her nurses. (nearly 5000km in a year!) (Top of NZ to bottom, back up, then back down again)
Importantly, she made sure that the nurses recorded data about the babies. This information was handed in and carefully copied into ledgers at the central office. A Doctor luckily remembered these records being

handed in and copied and told the scientists.
Interesting – initially, when Prof Barker asked to use the records he was not allowed. The records were to be kept private until the mothers had died because sometimes the nurses wrote harsh comments (what comments might these have been? Blaming mothers for poor health of babies when complex causes such as poverty and food insecurity where prevalent?)
By coincidence, Prof Barker had lived in one of the villages during the war, and his sister was born in the village. Because of this, Prof Barker was allowed to use the records because they trusted him to keep them confidential.
These records are the famous Hertfordshire records from 6 villages that enabled the scientists to make comparisons between then and 60-70 years later. (Why did they need a large number of records?)
They found some very exciting and interesting information.
The scientists traced those babies to find out who was still alive, who had died, 50 years later.
They found a link between low birth weight and slow weight gain in the first year and heart disease. What processes are responsible?
The scientists interviewed thousands of Hertfordshire babies who were still living – a happy consequence was that the participants enjoyed connecting with others from their early childhood as they sat in waiting rooms ready to be interviewed.
Scientists found that people who are small at birth – for example, possibly due to insufficient nutrition – remain biologically different throughout their lives. They have higher blood pressure, are more likely to develop type-2 diabetes and heart disease – this area of science is now called DOHaD and proposes that the responses of a foetus or infant to undernutrition can permanently change how the body deals with food.

For example they weighed the babies on spring balances (maybe you have used these in science class as force meters?).



Weight at Birth.	Weight 1st Year	Food.	No. of Visits.	Condition, and Remarks of Health Visitor. W	V	D	T
8¼ lbs	24½ lbs	B.	11	4	-	-	4
Healthy & well developed. Buckland School. Card to S.							
7 lbs	18¼ lbs	B	12	h.	4.	4.	8
moved to Bury Green Lt Hadham. Had measles, pneumonia &							
8	20	B&C.	11	Y.	Y.	?	4
I.B. ulcer in stomach opened. Ant. fontanelle still open @ 3 yrs. Abdomen very large & pr							
8½	22	B.B.	9	Y	Y	Y	10
Healthy & normal. Buckland School. Card.							

An extract from the health visitors records

Miss Burnside began her work in 1906 supporting midwives to improve the health of mothers and their babies.

Miss Burnside's midwives all kept meticulous records to try to improve the health of the children and their mothers.

The midwives recorded information for each child:·Professor Barker and his team used these health records to trace 15,000 men and women born in Hertfordshire before 1930.

They discovered that 3000 had already died, half from heart disease or related disorders.

They found it was more likely that those who had died had been small at birth.

The team contacted those that were still alive, told them about what they were doing and why, and asked if they would like to help by taking part in the study.

The information was entered into a computer data base and matched with data from death certificates

A clear link was found between low birth weight and increased risk of dying from heart disease in later life.

This was the first study to show this (Barker, 2003).

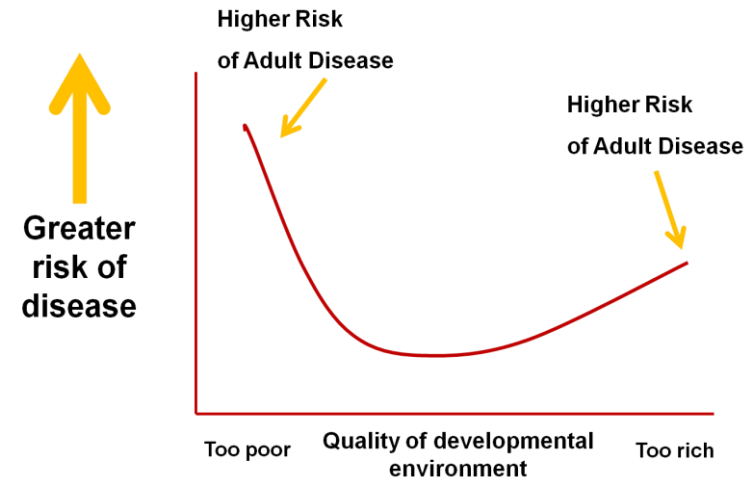


Figure 7 The environment that a fetus experiences in the womb affects the risk of the child developing disease as an adult.
(Redrawn with permission from Godfrey, Gluckman & Hanson , *Developmental origins of metabolic disease: life course and intergenerational perspectives;* Trends in Endocrinology and Metabolism Vol.21 No.4, 2010)

They discovered that people who were smaller at birth were at age 65 more likely to have
· high blood pressure
· Type 2 diabetes
· and a number of other characteristics that made them overall less healthy.
The graph shows the results for Type 2 diabetes
It is important to remember that low birth weight did not cause the increased risk.
Low birth weight is an indication that the pregnancy was not as healthy as it might have been.

This field of scientific research is now called DOHaD – Developmental Origins of Health and Disease.

Complex causes of health and disease…