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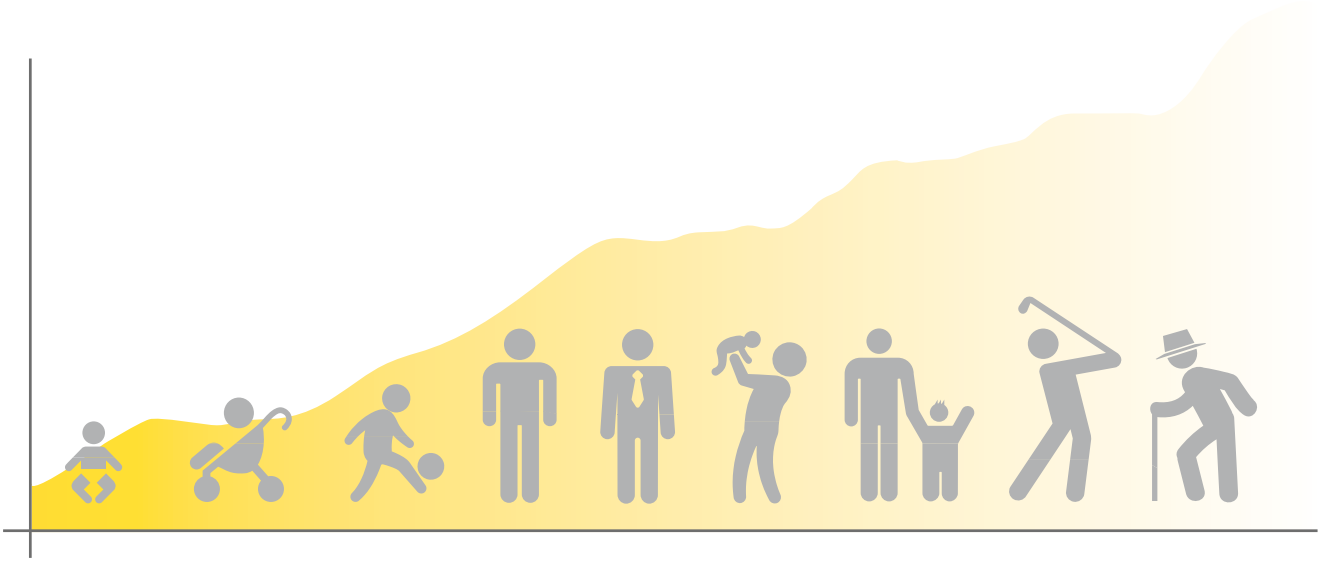

Human milk for preterm infants: Health and economic value

Executive summary

The uniqueness of human milk
Human milk consists of thousands of different components, including proteins, fats, lactose, vitamins, iron, minerals, water and enzymes which protect and promote the optimal development of the infant. It also contains antimicrobial, anti-inflammatory and immunomodulatory factors not present in the milk of other mammals. These components of human milk interact in a synergistic way to reduce the incidence, severity and risk of debilitating morbidities in hospitalised and preterm infants. Importantly, this happens in a dose-response manner – the more milk, the greater the benefit – and has an especially potent impact in the first months of life. The compelling benefits of human milk are such that all preterm infants should receive it, making the feeding of human milk a NICU priority.

Health benefits of human milk
Preterm infants fed human milk have better health outcomes than formula-fed infants. These include a statistically significant reduction in the risk of morbidities such as necrotising enterocolitis (NEC) and sepsis, both of which are particularly associated with preterm birth, and their comorbidities like long-term disabilities and death. There is also evidence that feeding term or preterm infants human milk instead of formula reduces the risk of sudden infant death syndrome (SIDS), leukaemia as well as chronic and infectious morbidities, including otitis media and obesity.

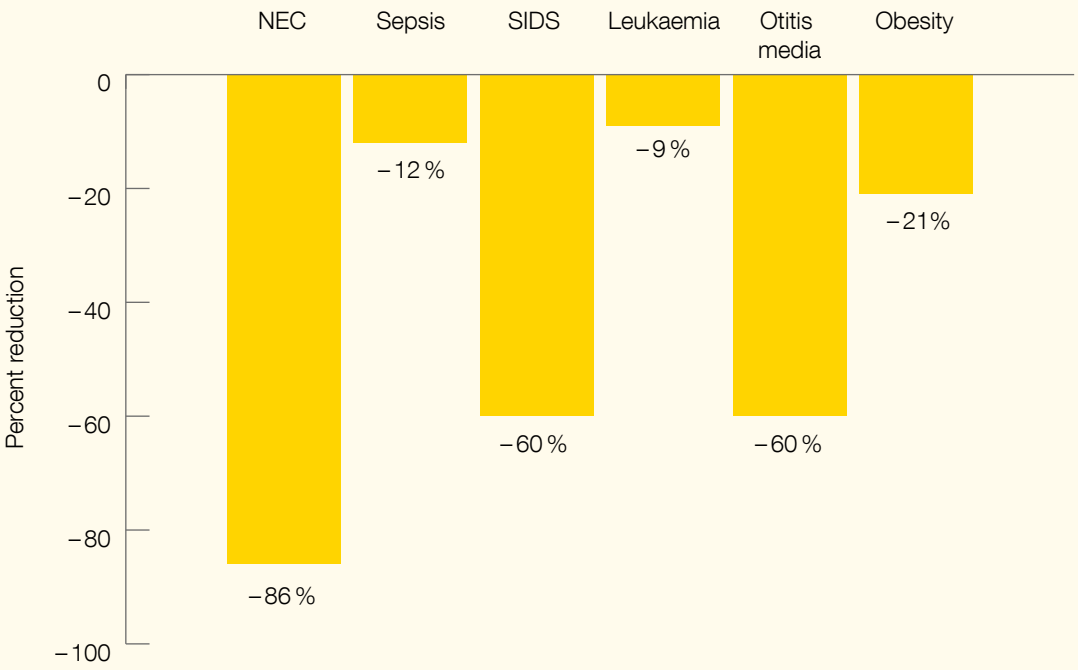

Figure 1: Risk reduction for specific complications through exclusive use of human milk compared to formula feeding in preterm infants (partially modelled from term infant data) [1].

Although a preterm infant is fed human milk mainly during the first year of life, the benefits in terms of health, economics and quality of life last far beyond this point in time. An economic discussion about human milk should therefore consider the advantages it brings to this population over an entire lifetime. This holistic perspective alone shows its real value to a healthcare system comprising providers (hospitals and professionals), payers (insurers and society), policy makers (governments), and patients. This approach provides additional powerful arguments for the use of human milk for preterm infants. Consequently this offers the basis for promoting not only human milk as the optimal nutrition for the preterm infant, but also initiatives designed to support mothers and hospitals in their efforts to ensure that this is done.

Reducing healthcare costs

The York Health Economics Consortium (YHEC) developed and published a model to calculate the economic value of human milk for preterm infants. The model is based on high quality evidence showing the reduction of certain diseases and complications through human milk feeding. The UK and the German healthcare systems were used to derive the economic value of these benefits [1].

The decrease in complications, diseases and mortality rates used for this health economic model are generally applicable to the wider population. The cost savings per preterm infant through human milk can be expected to be similar in economies comparable to those of the UK and Germany.

The models for the UK and Germany concluded that the reduction of these diseases leads to average cost savings over a lifetime of € 1 357 for each preterm infant that is fed human milk instead of formula. Of this figure, € 780 is accounted for by the period before the infant is discharged home from hospital and € 576 by the reduction of long-term, post-discharge complications and diseases. This equates to overall annual savings of € 62 million for the populations of England / Wales and € 89 million for Germany every year if all preterm infants were fed human milk instead of formula.

> The economic value of human milk is systematically underestimated

Improving productivity and quality of life

By reducing the mortality rates of preterm infants, feeding with human milk also improves the productivity of a society. For every 1 000 infants fed human milk instead of formula, approximately 4.3 lives are saved. The lifetime earnings of these saved lives could result in a retained productivity of € 201 million in England / Wales and € 174 million in Germany every year if all preterm infants were fed human milk instead of formula.

The impact on the quality of life of the preterm infants and their families may be more important than the direct cost savings. Thanks to the evident reduction of specific morbidities and mortality, feeding with human milk could extend both life expectancy and the health-related quality of life. It has been estimated by YHEC that improvements in health outcomes through exclusive feeding with human milk would increase the Quality Adjusted Life Years (QALYs) by 0.21 on average for any preterm infant fed human milk instead of formula. The UK National Institute for Health and Care Excellence (NICE) considers an investment of £ 20 000 (~ € 26 178) per QALY as cost effective. Therefore an average improvement of 0.21 QALYs justifies investments into human milk and breastfeeding interventions up to € 5 364 per preterm infant or € 277 million for the entire preterm infant population of England / Wales every year.

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Epidemiology of preterm birth

Globally, prematurity is the leading cause of mortality in children under the age of five, accounting for 35 % or more than 1 million deaths each year [2, 3].

An infant is considered preterm when born earlier than 37 weeks of gestation. Because of the sudden interruption of their development, they are at much higher risk of suffering a wider range of complications than term infants. The infant's development must continue in a very different and less protected environment than that in the womb.

Yearly almost 15 million infants are estimated to be born preterm, 11 % worldwide, ranging from 5 % in some European countries to 12 % in the USA and up to 18 % in some African countries [3]. Preterm birth rates are increasing in almost all countries for which reliable data is available [3].
The smaller the infant in terms of birth weight and the more preterm it is born, the higher the risk of infant death and health complications in later life (Figures 2 and 3).

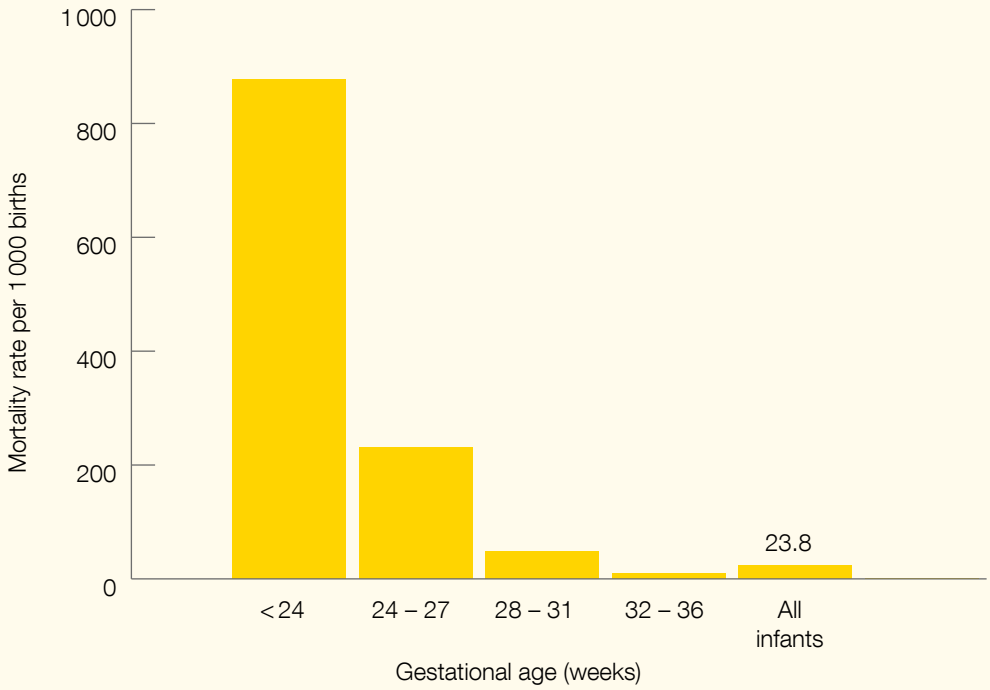

Figure 2: Neonatal mortality rates in England/Wales by gestational age (created from National Centre of Statistics [4])

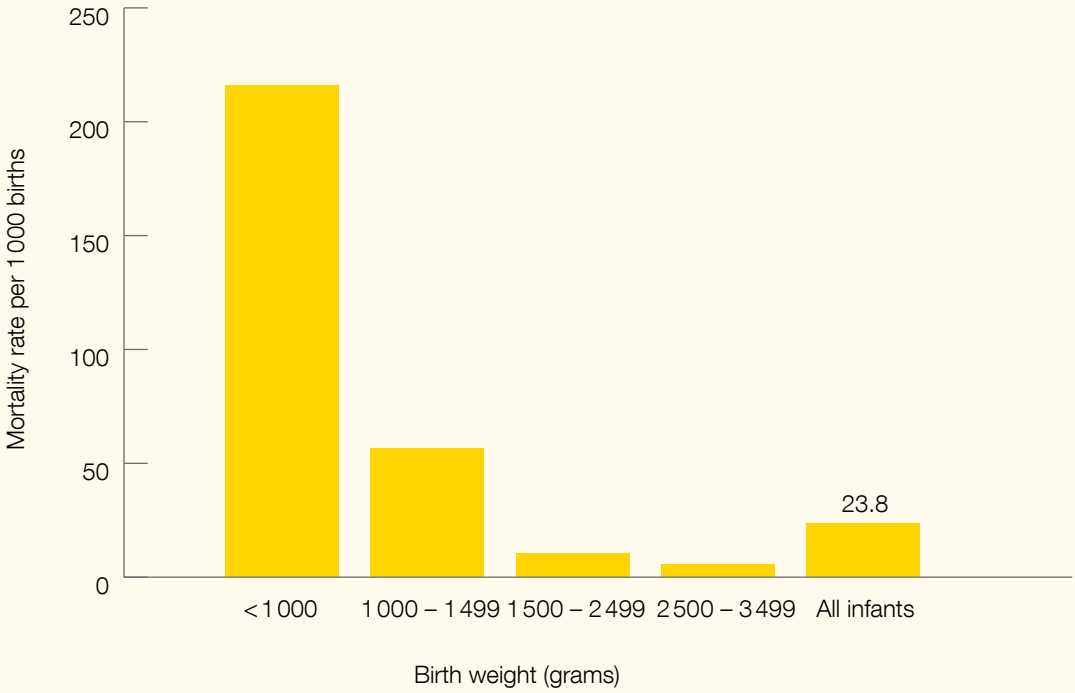

Figure 3: Neonatal mortality rates in England/Wales by birth weight (created from National Centre of Statistics [4])

Thanks to advances in medical technology and treatment, preterm birth mortality rates are continually decreasing, with ever smaller infants surviving. However, this also means that other health complications have become more prevalent today. They include devastating diseases such as necrotising enterocolitis (NEC), sepsis and neurodevelopmental impairment [5].

Preterm birth accounts for almost half (47 %) of the costs for all infant hospitalisations [6]

Many of these complications stem from the immaturity of the gastrointestinal tract as well as other organs and physiological systems of the preterm infant. More attention is consequently being paid to the crucial role played by nutrition in the health outcomes of these infants [5]. An increasing body of research has demonstrated that human milk improves the host defence system, gastrointestinal development and neurodevelopmental outcomes of preterm infants [7–16].

Human milk:
unique – irreproducible – irreplaceable

Human milk is species-specific and adaptive to the needs of the infant and mother in quantity and composition [17]

Human milk has been adapted through evolution to meet the needs of the term born infant by supporting its survival, growth and development. It does so by providing all the necessary components, including essential macronutrients (fats, carbohydrates and proteins), micronutrients (vitamins and minerals), and developmental factors (long-chain polyunsaturated fatty acids, growth factors and cytokines).

Human milk also contains commensal bacteria that become part of the gut microflora and influence inflammatory and immunomodulary processes [18]. New human milk components are continually being discovered [19, 20]. These unique components, their complex interactions, species-specificity and bioactive roles in the infant make clear why feeding human milk has such a powerful impact on infant health compared to formula feeding. Our continually evolving understanding and discovery of the components of human milk makes its irreproducible character abundantly evident.

> The reduction of complications through human milk feeding shows a dose-response pattern: the more and the longer human milk is fed, the greater are the positive effects [21]

Human milk significantly lowers the rate of some of the most serious complications and improves overall outcomes in the short and long-term. This results in health and economic advantages for the infants and their families in terms of an improved quality of life, lower cost of care for the hospital and the healthcare system, as well as a higher productivity for the society as a whole.

The health economic value of feeding human milk to the preterm infant

By significantly improving short and long-term outcomes, human milk saves costs for all healthcare stakeholders and the wider society while at the same time improving the quality of life of preterm infants and their families

Preterm infants usually stay in the hospital during the first days or weeks of their life. Many measures taken and decisions made at this stage will influence their lifelong health and wellbeing. These include the decision of the mother to breastfeed and of the hospital to support breastfeeding, and, if this is not possible, to support the expression and provision of human milk. From a health and economics point of view, however, looking at the benefits that human milk feeding provides during this period of hospital stay or during the breastfeeding period shows only part of the picture.

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YHEC
York Health Economics Consortium

A complete health economics assessment of human milk for preterm infants also needs to look at its long-term effects and what impact these have on the costs for all healthcare stakeholders, including hospitals, insurers, governments and the wider society. This includes the impact of human milk on an individual's subsequent quality of life, earning potential and productivity. The health economic value of human milk for preterm infants was independently calculated for Medela by the York Health Economics Consortium (YHEC), an Institute of the University of York, UK. Using standard health economic assessment methods based on high-quality clinical evidence, YHEC derived a value for preterm infants in terms of treatment costs, earnings and quality-of-life improvements resulting from a diet of either human milk or formula [1].

The health outcomes used as an input to this assessment are based on internationally published clinical data. For the monetary input necessary to calculate the economic value of these outcomes, the two different health care systems of the United Kingdom (UK) and Germany were used. The detailed data input can be found in the back of this brochure. It can be expected, that the outcomes of the model are similar in economies that are comparable to those of these two countries.

Short-term health outcomes and cost savings in the hospital

The short-term health outcomes of preterm infants are those that occur during their initial hospital stay in the neonatal intensive care unit (NICU). They are also most relevant for the hospital in economic terms. The treatment, control and management of diseases and complications at this stage often require special care, specific technology or medicines as well as time.

Necrotising enterocolitis and sepsis

Necrotising enterocolitis (NEC), an acute inflammatory bowel disease that can lead to perforation of the gut and peritonitis, is the most common serious gastrointestinal disease seen in NICUs. The incidence rate for NEC among preterm infants is reported to be 2.6 %[22]. NEC requires immediate medical treatment often followed by surgery. The average length of stay for NEC treatment is 27.2 days[23]. This extended period is also the main driver behind the high costs of NEC, namely € 22 816 per case on average[24, 25].

Sepsis is another very frequent complication in the NICU, with a reported high incidence rate of 16 %[26]. Infants treated for sepsis have to be kept in the hospital for 5.9[23] days longer on average[22] resulting in average costs per case of € 6 993[24, 27].

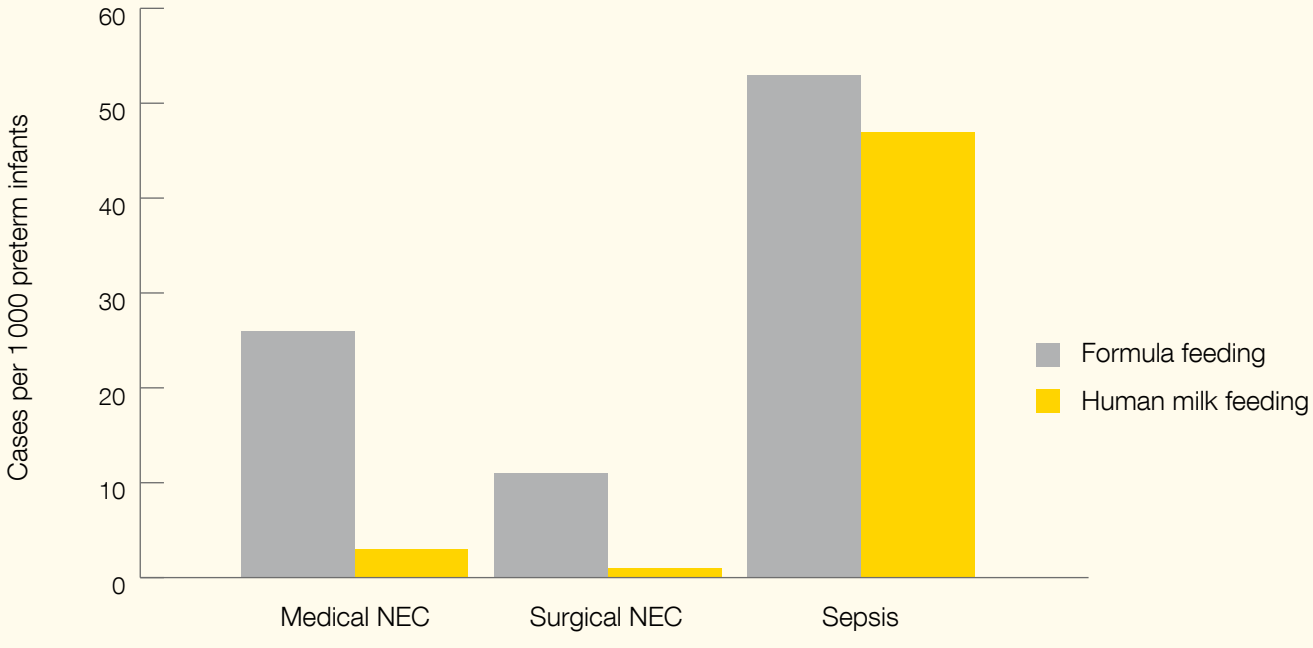


Figure 4: Incidence rates of NEC[22] and sepsis[7, 8]

It is well established that feeding with human milk significantly reduces the risk of NEC and sepsis in preterm infants [9, 10, 13, 15, 16, 21]. Exclusive feeding with human milk lowers the rate (Figure 4) and therefore the costs of NEC by 86 %, and those of sepsis by 12 %, when compared to exclusive formula feeding. Human milk thus represents an enormous potential for cost savings during the initial hospital stay. For every preterm infant fed human milk instead of formula, an average of € 780 is saved by lowering the rates of NEC and sepsis and hence avoiding the costs of their treatment and occupied NICU beds (Figure 5).

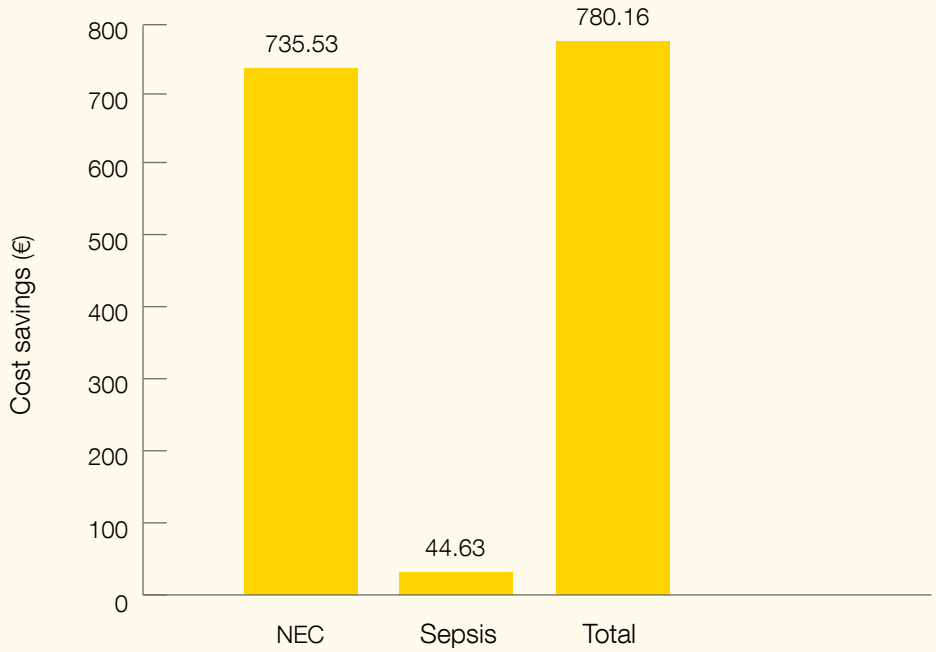


Figure 5: Average cost savings during the initial hospital stay per preterm infant from improved short-term health outcomes through human milk feeding [24, 27].

Despite extensive treatment, these conditions are nevertheless associated with high reported mortality rates, namely 15 % for NEC [22] and 20 % for sepsis [26] (compared with 9 % for non-septicaemic preterm infants). The direct net costs generated by neonatal death are rather low and are negligible for a cost assessment. However, the death of an infant means enormous emotional and psychological stress for the parents as well as a loss of productivity and earnings to society. The economic assessment of an infant's death is presented on page 19.

In addition, the survivors of these diseases are often affected with long-term disabilities such as neurodevelopmental impairments. Therefore, avoidance of these diseases also means a direct reduction in some long-term complications.

Long-term health outcomes and cost savings after discharge

The incidence rates of several poor health outcomes and diseases that usually appear after the infant has been discharged from hospital are significantly reduced in infants fed human milk [28–34]. This underlines the fact that the positive medical and economic effects of human milk remain long after its actual application.

Leukaemia

Acute lymphoblastic leukaemia (ALL) is the most common type of cancer to affect children. Fortunately the incidence rate for this disease is rather low, at 0.04 % (cumulated until the age of 15). While there is no known difference in incidence between term and preterm-born infants, research suggests that exclusive feeding with human milk can reduce the rate of leukaemia by 8.6 % [35] (Figure 6). In view of the high average treatment costs of € 136 441 [36] due to the long hospital stay (84 – 210 days [36]), therapy and subsequent complications such as infections (accounting for 18 % of the total costs [36]), the economic value of reducing even such low incidences is still significant.

Acute otitis media

Cases of acute otitis media (AOM), an infection of the middle ear, occur frequently in infants and are generally associated with outcomes that require minor treatment. Acute otitis media can be considered a less severe disease. The average treatment costs are estimated to be € 721 [37, 38]. The AOM incidence rate can be reduced by 60 % by breastfeeding (Figure 6).

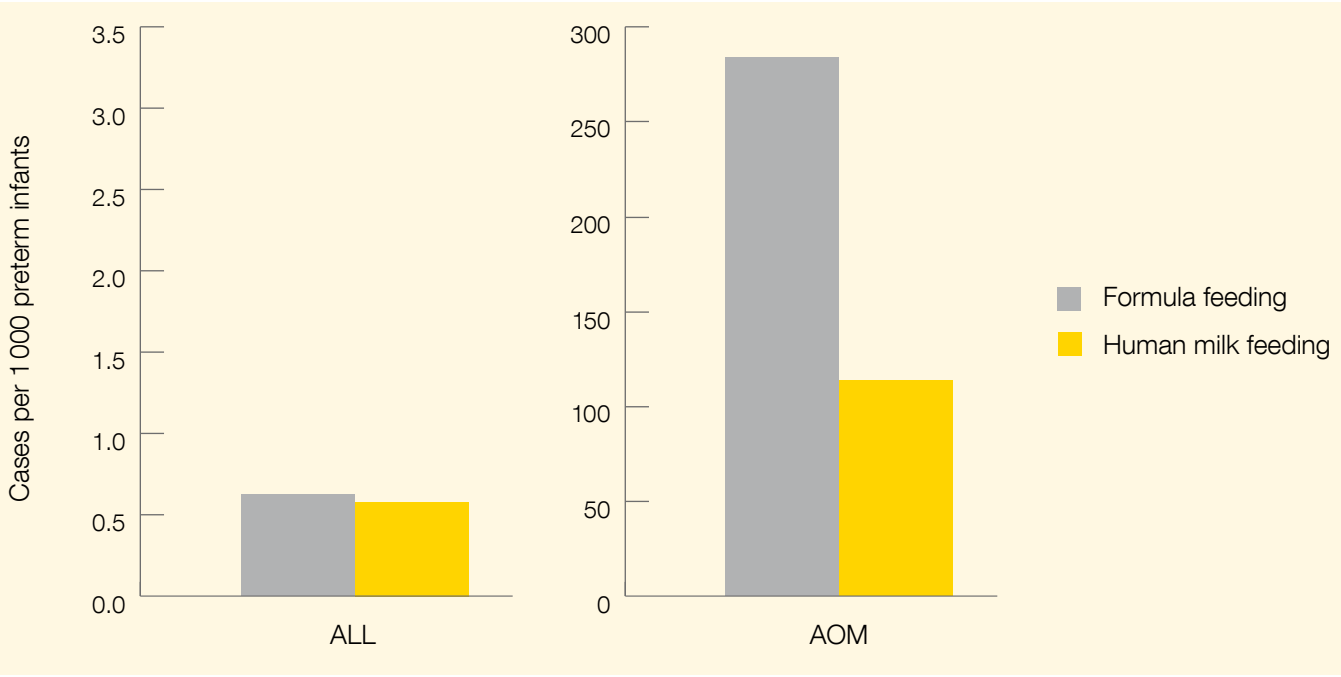


Figure 6: Incidence rate of acute lymphoplastic leukaemia (ALL)[35] and acute otitis media (AOM)[32]

AOM and ALL are treatable diseases marking the two ends of the spectrum of benefits from human milk. On one end, otitis media does not usually involve high treatment costs or have a high impact on the quality of life, but it does have a high incidence rate. On the other end, leukaemia has a low incidence rate but requires extensive treatment that increases other comorbidity rates.

Neurodevelopmental impairment

Neurodevelopmental impairment (NDI) is a composite measure that captures many elements of disability, including visual impairment, hearing impairment and limitations of mobility. These disabilities can be categorised as mild, moderate or severe. Many of them are the long-term comorbidities of complications such as sepsis and NEC that developed during the initial hospital stay of the preterm infant. The rate of these disabilities can be reduced by feeding a human milk diet [9, 10, 13, 15, 21, 39]. Affected infants often need lifetime support, medical attention and social care. The difference between infants fed with human milk and with formula is a small but statistically significant risk reduction of 1.4 % over all disability levels among the former [40] (Figure 7). This may seem quite low, but as the average costs of € 19 546 (mild disabilities) up to € 511 087 (severe disabilities) [41] per case are very high, the economic benefits of human milk feeding can be substantial.

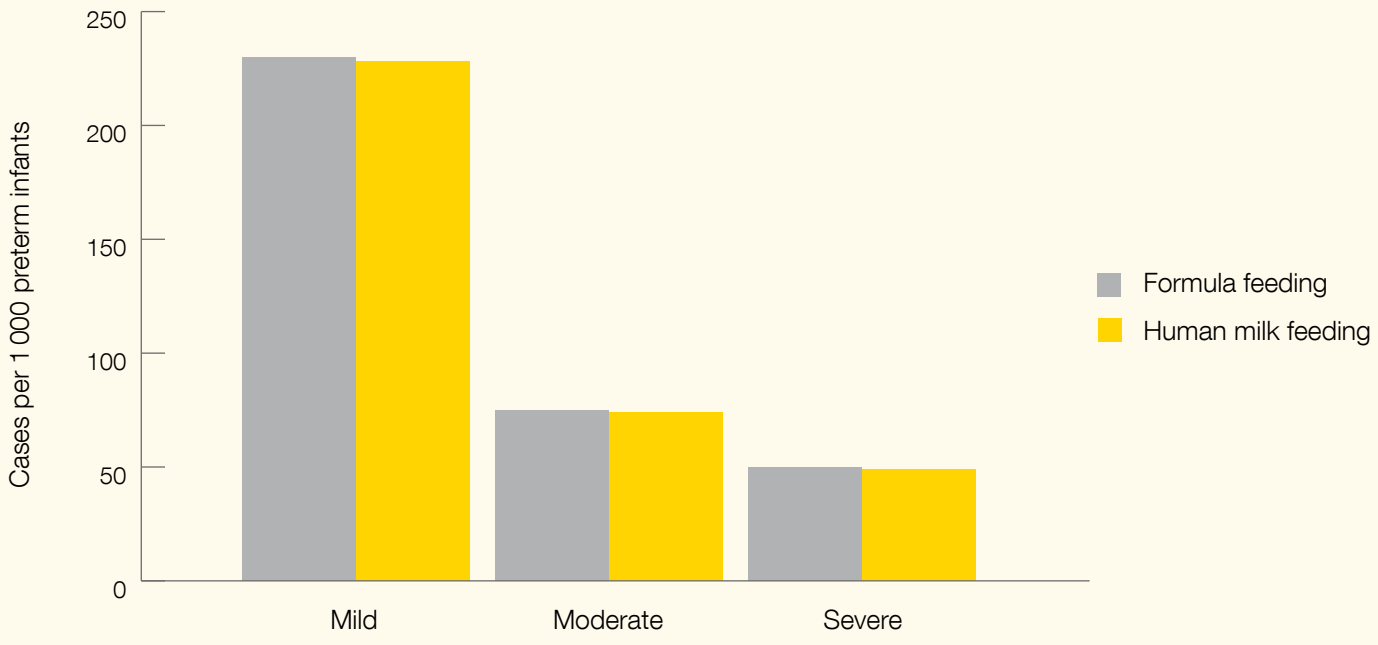


Figure 7: Incidence rate of disability [29–31]

Obesity and its contribution to diabetes and coronary heart disease

Breastfeeding has been demonstrated to have a protective effect against childhood obesity, which is strongly associated with adult obesity [42]. The comorbidities of obesity include increased rates of type 2 diabetes and coronary heart disease (CHD) in later life. By reducing the rate of childhood obesity by 20.7 %, human milk may also lower the risk of acquiring these two diseases (Figure 8).

Type 2 diabetes
This type of diabetes is diagnosed at an average age of 55, and patients require their condition to be managed until the end of their lives. Since the average life expectancy is 75 years [42], this implies 20 years of treatment costs [43, 44]. As feeding with human milk effectively lowers these diabetes rates immediately after birth (55 years before the actual diagnosis and treatment), the consequent cost savings need to be discounted in order to represent their real value today. This is done at an annual discount rate of 3.5 % [45], so that the average cost savings of € 54 251 [44, 46] per avoided case, 55 years after the infant is fed human milk, translate into an average present value of € 6 709 at the time when the intervention is first invested (see "Definitions" section for more details on discounting costs).

Coronary heart disease
CHD is the most common type of heart disease. The average age for being diagnosed with CHD is 65. On the basis of a general life expectancy of 75 years, this translates into ten years of treatment (YHEC).

Ten years of treatment and the overall average costs per case of € 51 463 [44, 47] discounted back, result in an actual economic value of € 6 873 per case avoided through the use of human milk.

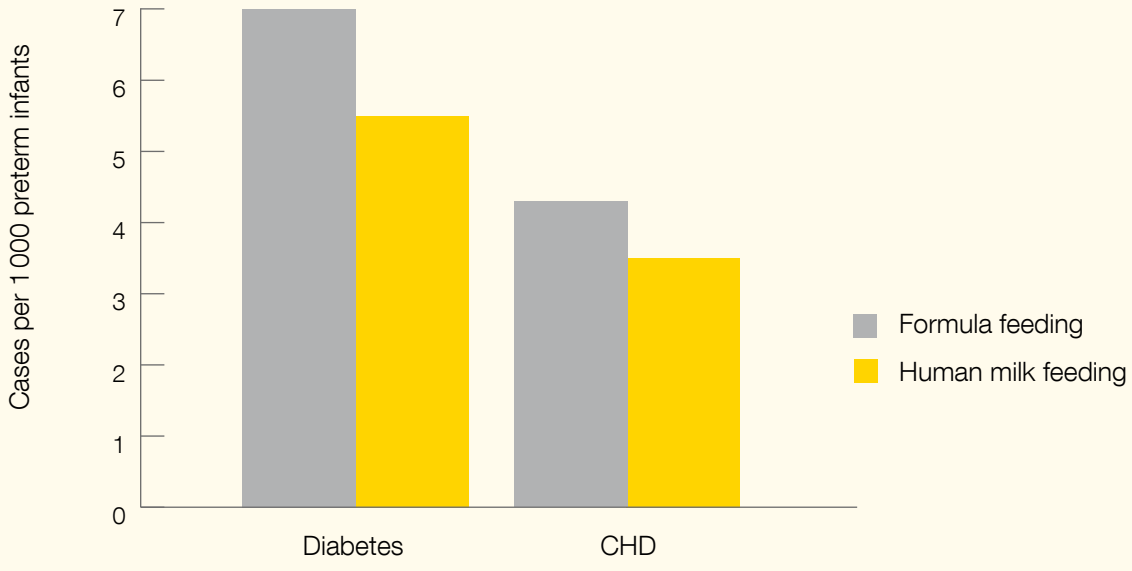


Figure 8: Incidence rate of obesity-related morbidities [33, 34, 48]

Long-term cost savings

In terms of severity and cost, the long-term complications and diseases that can be directly or indirectly reduced by human milk and breastfeeding are as substantial as those occurring during the initial hospital stay.

> The long-term cost savings through human milk contribute substantially to the total cost savings

The share of the prevention of these long-term complications and diseases results in average direct cost savings of € 576 per preterm infant (Figure 9).

Unlike the acute complications that mainly affect the hospital as a treatment institution, these long-term savings are relevant across the entire healthcare system including the government, health and social insurance and the tax payer.

All these healthcare stakeholders consequently benefit from the cost savings provided by feeding preterm infants human milk.

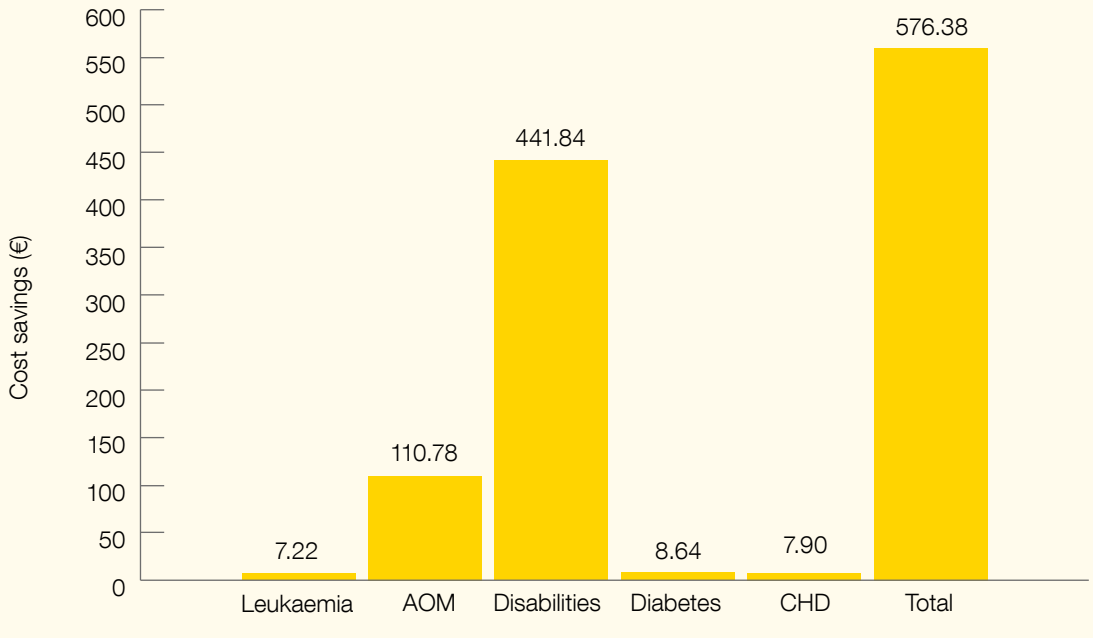


Figure 9: Average cost savings per preterm infant from improved long-term health outcomes through human milk feeding [32, 36, 50–52]

Total cost savings of feeding human milk to the preterm infant

Feeding human milk during the first years of life can be viewed as a “therapy”. It reduces comorbidities and diseases over the infant’s entire lifespan and produces significant direct cost savings that go far beyond the intervention time period.

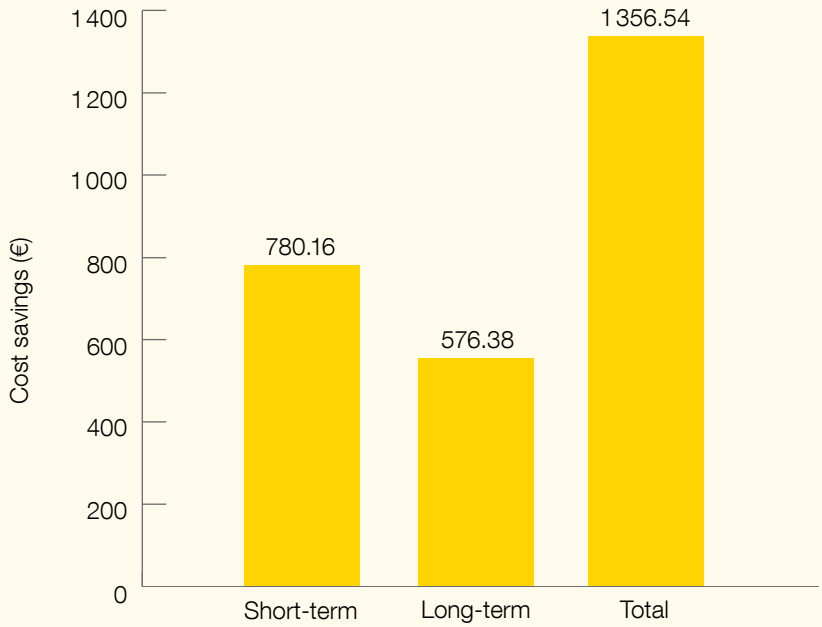


Figure 10: Average lifetime cost savings per preterm infant from improved health outcomes through human milk feeding

When using the average costs from the German and the UK healthcare systems as examples, for every preterm infant that is fed human milk instead of formula there is an average cost saving of € 1 357 (Figure 10). These numbers are expected to be of similar magnitude in comparable economies.

For the populations of England / Wales with 51 703 [53] and Germany with 58 627 [54], this results in a total value of € 62 and € 89 million of direct cost savings annually, respectively if all preterm infants are fed human milk instead of formula.

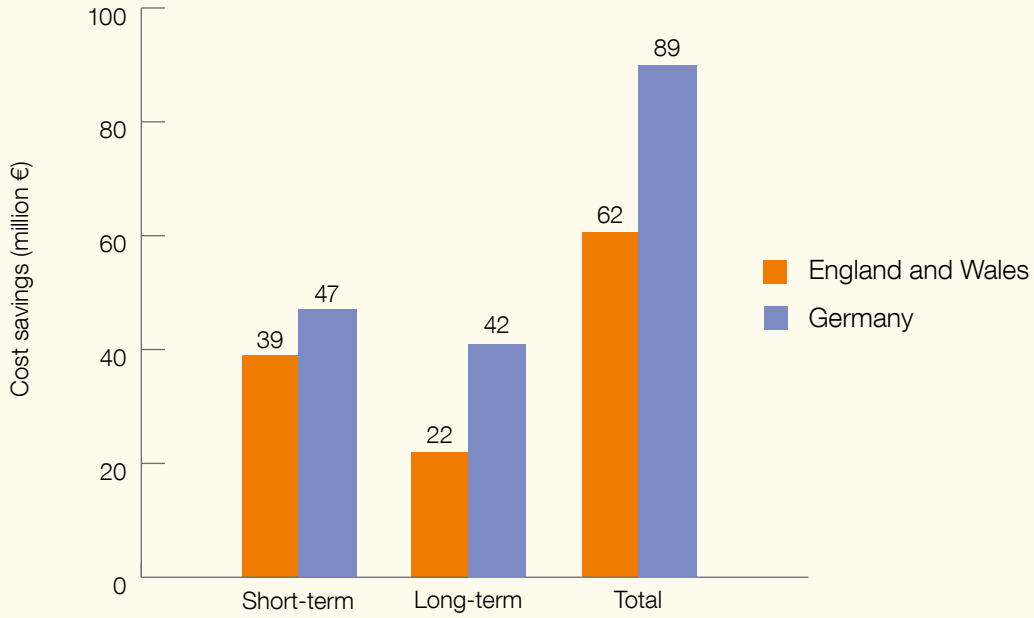


Figure 11: Total cost savings for the populations of England / Wales and Germany if all preterm infants were fed human milk instead of formula

In view of this enormous savings potential, everything possible should be done to provide preterm infants with sufficient human milk for as long as possible. WHO recommends exclusive breastfeeding for the first 6 months of life, after which appropriate complementary foods can be introduced while breastfeeding is continued for up to two years and beyond [49]. This means that NICUs, professionals and mothers should be given all support necessary, including education, training and appropriate equipment to make human milk provision and breastfeeding a reality for every preterm infant. The numbers presented here provide the value basis for such initiatives: every preterm infant that is fed with human milk saves direct healthcare costs of € 1 357.

Infant deaths and loss of productivity

Preterm birth directly accounts for 35 % of all neonatal deaths, and is a risk factor in over 50 % of all neonatal mortality[2, 3]. Many of these deaths are the subsequent effects of complications such as NEC and sepsis. Others, such as sudden infant death syndrome (SIDS), happen spontaneously without any prior complications. Just as for NEC and sepsis, however, the incidence rate for SIDS is much higher among preterm than full-term infants[55]. Breastfeeding can reduce this rate by more than half (Figure 12).

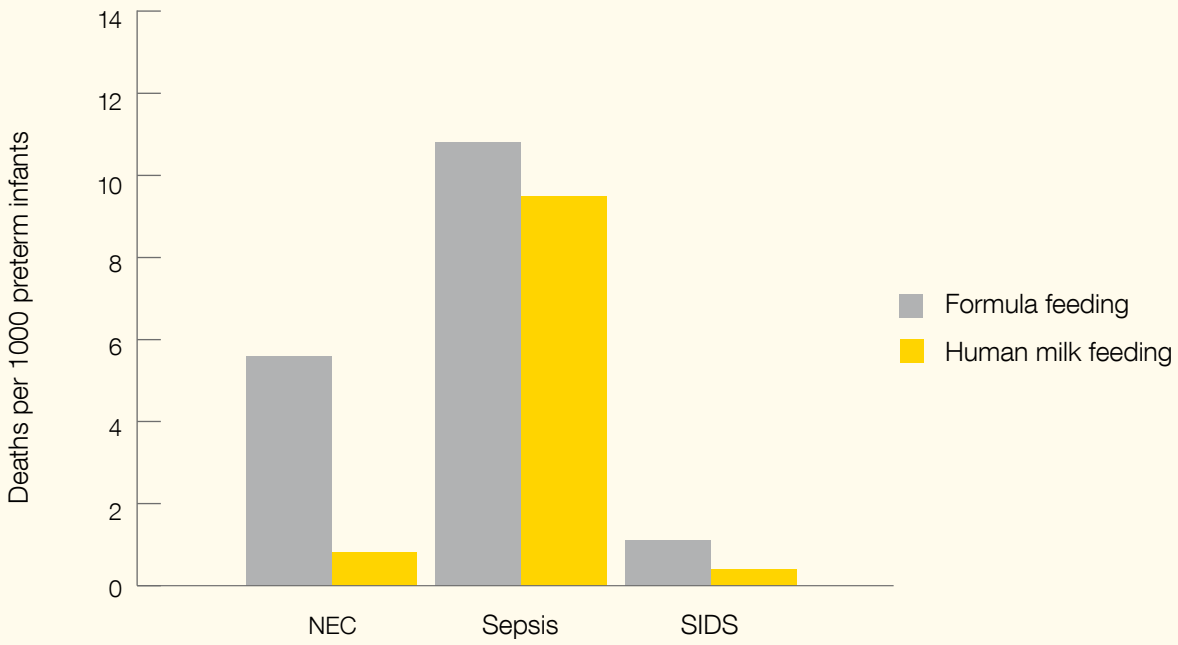


Figure 12: Mortality rates from specific diseases in formula and human milk fed preterm infants[22, 31, 56, 57]

The death of an infant means a significant loss of earnings to any society. Lower infant mortality rates translate into increased productivity and thus to higher earnings and greater wealth of a society. An infant who dies in the first year of life results in € 844 895[58, 59] of lost earnings on average.

The provision of human milk to all preterm infants would reduce the number of preterm infants experiencing NEC, sepsis and SIDS, and subequently prevent 4.3 in every 1 000 preterm infants from dying in the first year of life. Applying this to the entire preterm populations of England/Wales and Germany, results in 475 more infants surviving the first year of life if all preterm infants were fed an exclusive human milk diet instead of formula. This equates to a total of € 201 million for England/Wales and € 174 million for Germany in additional lifetime earnings annually.

Quality of life

Quality Adjusted Life Years (QALYs) are widely used to quantify the effectiveness of treatments in economic evaluations. They measure the health outcomes resulting from a particular treatment or intervention in the form of an expected utility gain (or loss). QALYs are based on a score from 0 for death to 1 for full health (Figure 13). As such they provide a common metric that enables comparisons to be made between interventions involving qualitatively varying health outcomes.

In an economic model, the QALYs gained by a treatment are given by multiplying the quality-of-life weight for each health state (i.e. the utility of that state) by the duration of time spent in that state. Each QALY corresponds to one year of life in full health.

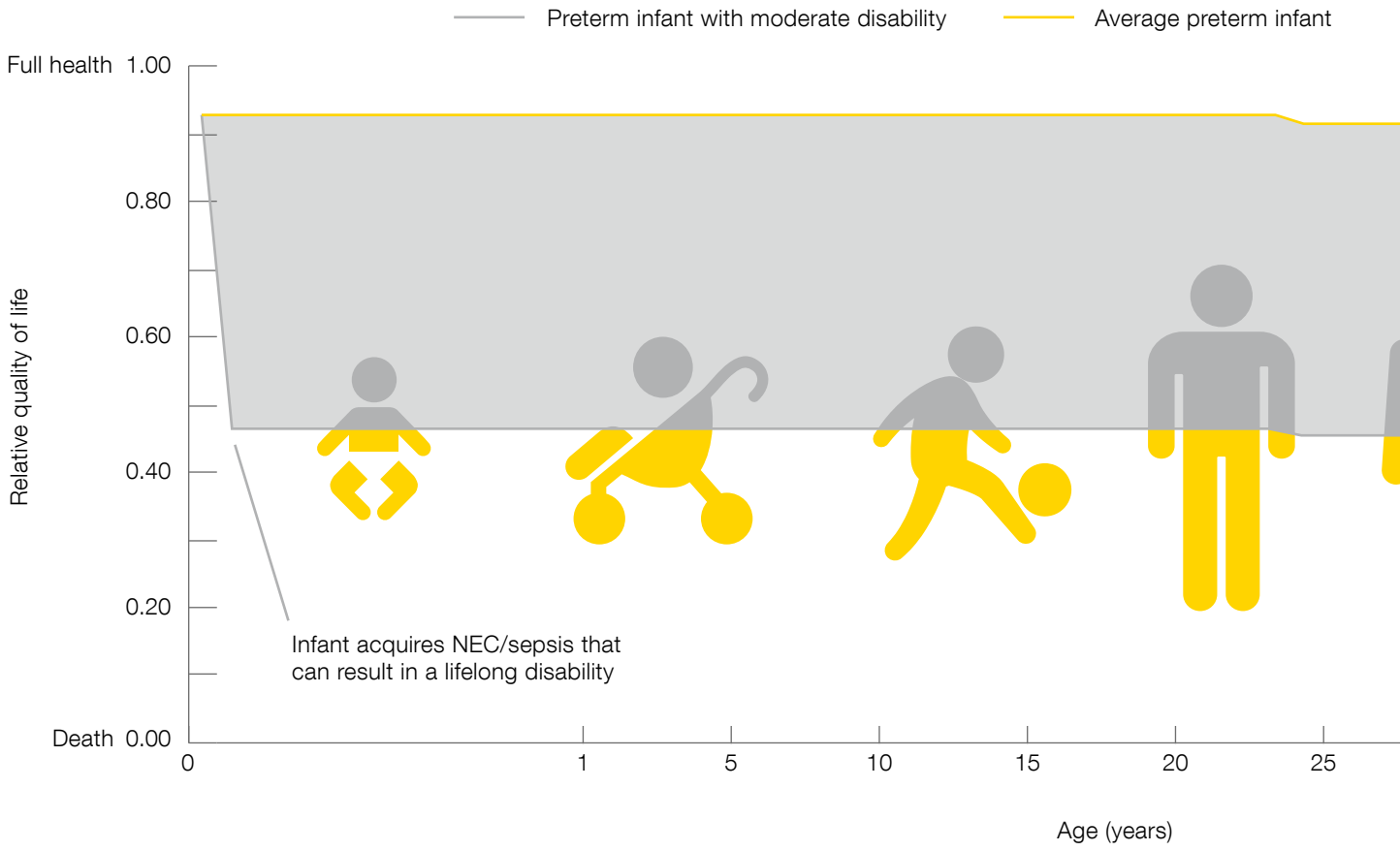
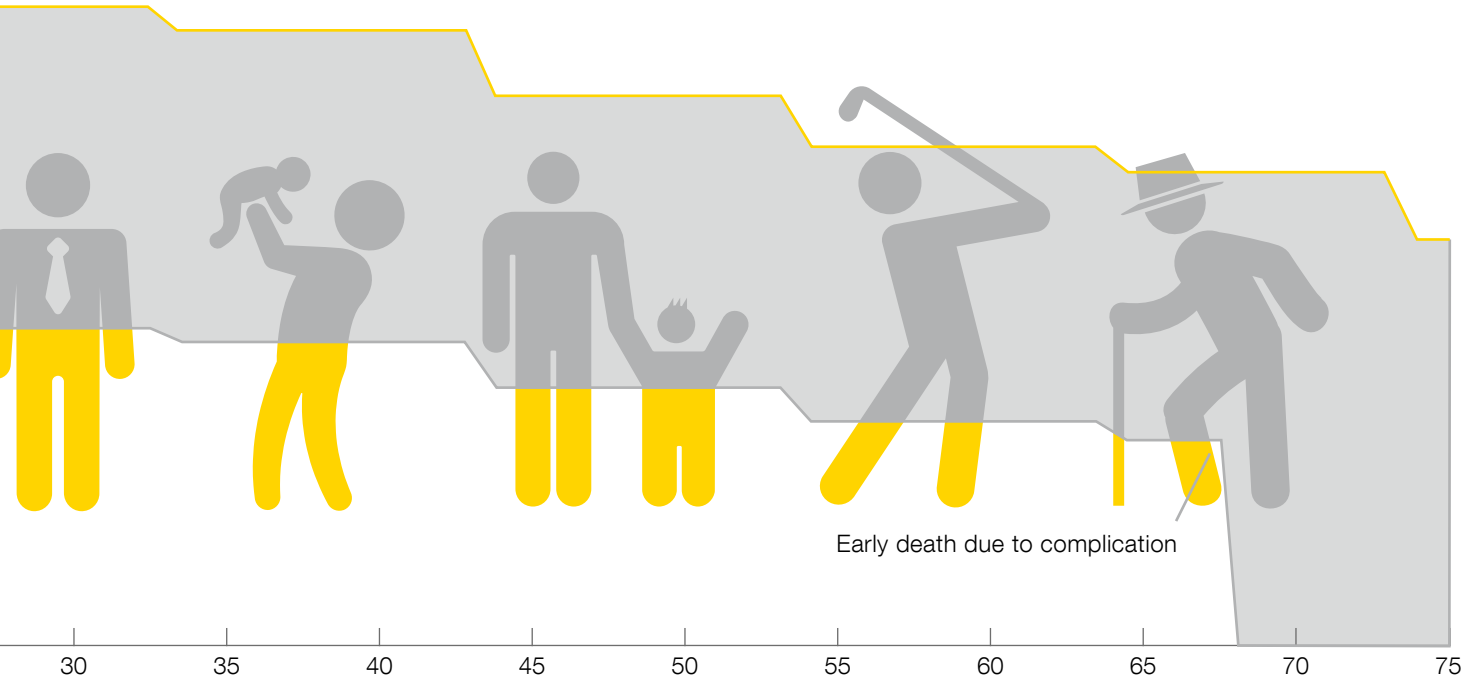


Figure 13: Changes in quality of life from a moderate disability acquired early in life (lower curve) compared to a healthy average preterm infant (upper curve). The area between the two curves represents the loss in Quality Adjusted Life Years (QALYs)

Comorbidities of preterm birth can affect both the duration and the quality of life of the preterm infant. This is especially apparent when considering long-term complications such as coronary heart disease, diabetes and other disabilities. Since human milk reduces the likelihood of developing these complications in preterm infants it also generates potential QALY gains for each infant.

As an example, the graphic below (Figure 13) shows the loss in quality of life over the lifetime of a preterm infant that acquired a moderate disability. The incidence for this complication is reduced by human milk feeding. The QALY loss by acquiring a moderate disability is represented by the surface area between the two curves (shaded grey).



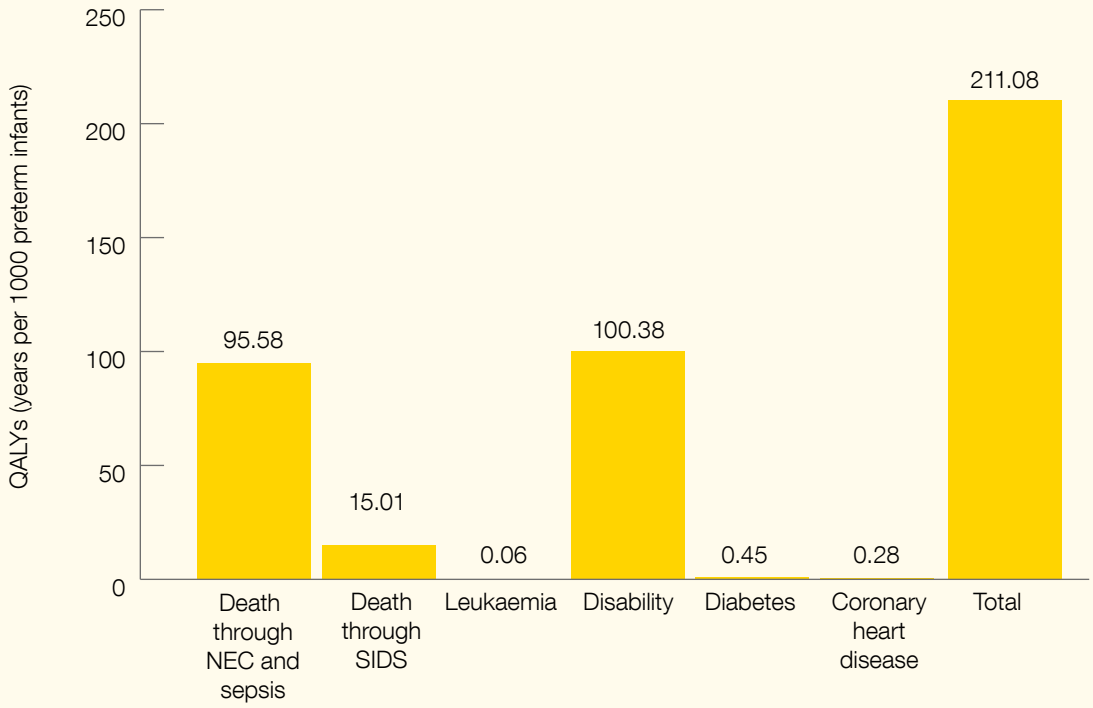


Figure 14: Quality adjusted life years gained through human milk feeding per 1000 preterm infants [22, 30, 31, 35, 50–52, 56]

On average, every preterm infant who has been fed human milk is expected to achieve 0.21 more QALYs (Figure 14) over their lifetime compared with a preterm infant who is formula-fed. For the populations of England/Wales and Germany this results in 11 208.7 and 12 158.9 QALYs respectively that are retained if all preterm infants were fed human milk instead of formula.

The UK National Institute for Health and Care Excellence (NICE) considers treatments that cost no more than € 26 180 per QALY gained as cost effective [60]. This means that an investment of € 5 364 (for an average 0.21 QALY gain) to achieve human milk feeding in one preterm infant would be considered to be cost effective. For the annual preterm infant population in England/Wales in total, this number adds up to € 277 million and for Germany to € 333 million.

Human milk: supporting cost savings and retaining productivity and quality of life

Human milk substantially improves health outcomes over an entire lifetime and reduces mortality rates in preterm infants. This reduces the costs of care, improves the productivity of a society and raises the quality of life. All these improvements make up the health economic value that human milk and breastfeeding preterm infants provides to all stakeholders of the health-care system, including governments, health and social insurers, hospitals, patients' families and society as a whole.

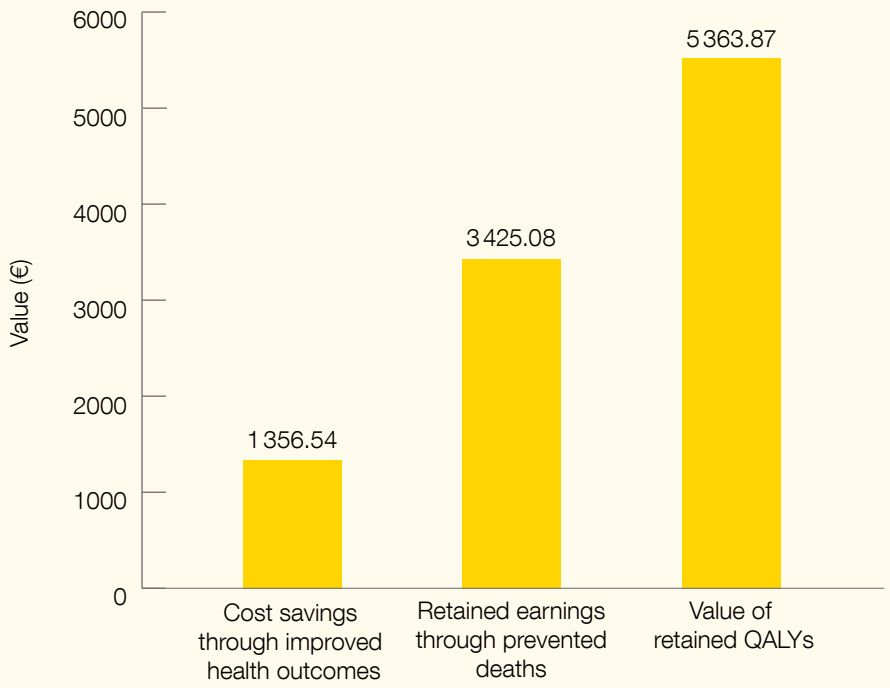


Figure 15: The health economic value of human milk per preterm infant from three different perspectives

For every preterm infant receiving a human milk diet in Germany and England / Wales, average direct health care costs of € 1 357 can be saved through the improved health outcomes that can be expected, earnings of € 3 425 can be retained thanks to a lower mortality rate and investments of up to € 5 364 are considered cost effective in terms of the QALY improvements that human milk feeding provides (Figure 15).

Translating this to the entire populations of England/Wales and Germany, shows the real health economic potential of feeding human milk (Figure 16).

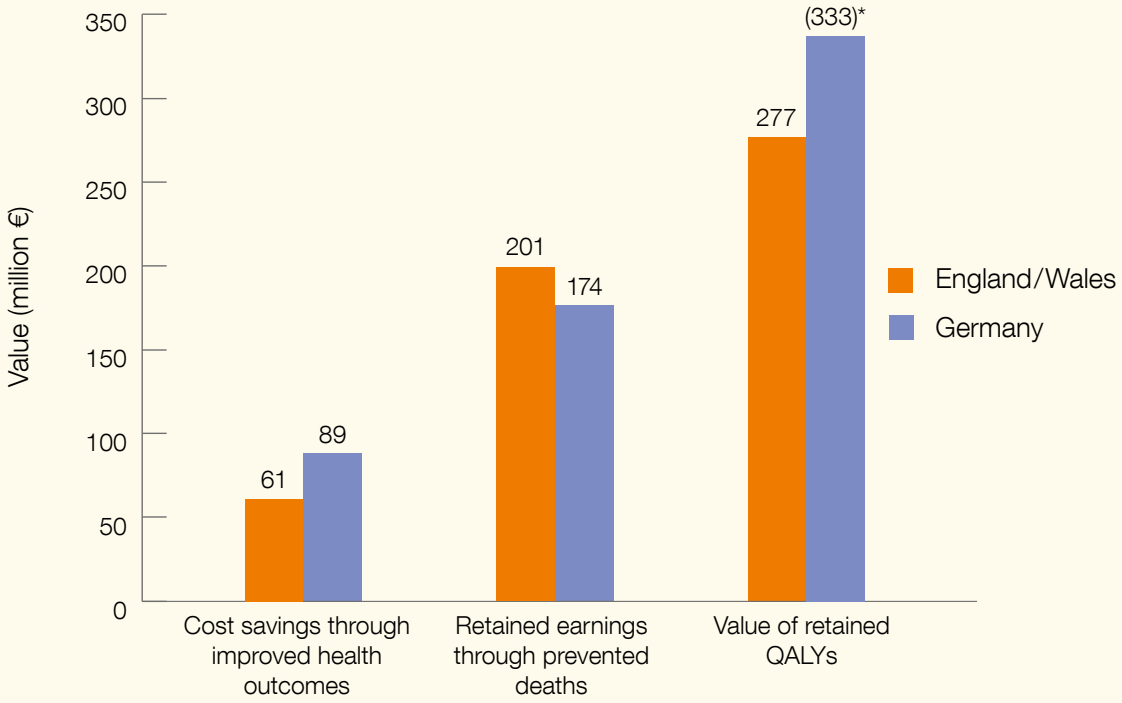


Figure 16: The annual health economic potential of feeding human milk to all preterm infants in England/Wales and Germany

These numbers give all healthcare stakeholders and decision-makers a basis for calculating the total value and returns on their investments in the provision of human milk. They can use the economic value of human milk per preterm infant in the relevant category (short or long-term healthcare cost savings, retained productivity or QALYs) and multiply it by the number of preterm infants they represent to obtain the value that human milk specifically has for them. The individual stakeholder can then consider how much it is worth to invest in initiatives, projects and products in order to obtain such value in return.

Preterm infant care in the hospital, where human milk feeding is initiated, is the most promising area of investment in order to unleash the full health and economic potential of human milk feeding. The numbers presented here show that society, governments and insurers benefit from this as much as the hospitals and patients. Hospitals and mothers should consequently not be left alone but should be supported in their attempts to breastfeed and to provide every preterm infant with human milk.

The health economic model in the broader context

Building upon the hard work of others, the approach taken by this economic model intends to place human milk and breastfeeding of preterm infants on the radar. The model aims to reach the entire spectrum of stakeholders by developing numbers for all infants born before 37 weeks and for a broad range of morbidities. These morbidities impact the preterm infant in the short term as well as over their entire lifespan. A 2016 publication series [61, 62] in The Lancet brought global recognition to the benefits of breastfeeding. The Lancet Breastfeeding Series Group highlighted the value of breastfeeding for a number of stakeholders in all countries. They report that achieving near universal levels of breastfeeding would prevent 823 000 annual deaths in children under 5 years of age [62]. Scaling up breastfeeding rates would also benefit mothers by preventing 20 000 annual deaths from breast cancer [62]. The staggering numbers continued with evidence that not breastfeeding is associated with lower intelligence and economic losses of about $302 billion annually or 0.49 % of world gross national income [61].

The global benefits of breastfeeding in both the short and long-term were clearly outlined by the comprehensively written series, with the ensuing call for more efforts to protect, promote and support breastfeeding. However, as addressed in a correspondence to the series [63], the articles do not address those infants most vulnerable, those born preterm and otherwise ill. These high-risk infants need special protection and support to enable breastfeeding and feeding with human milk. Investing resources into promoting human milk for those born too soon, where the benefits are even more profound and quantifiable, should be a priority.

One of the major reasons human milk and breastfeeding rates in the preterm population are only minimally discussed globally is the lack of standardised data collection tools to capture the issue. Where specific data does exist, the results are startling. For example, in the USA a research team at Rush University Medical Center has published numerous articles on the specific, direct costs of care for very low birthweight infants in their Chicago-based hospital [21, 64–67]. The researchers highlight the costs of the morbidities including, necrotising enterocololitis, sepsis and bronchopulmonary dysplasia, and go even further by describing the potential cost savings of human milk as a strategy to reduce their incidence [21, 64]. Their research carefully describes the dose-response relationship i.e. the higher the dose of human milk, the lower the incidence and severity of these morbidities and the lower the cost of hospitalisation [65, 66].

The achievements of the Millennium Development Goals (2000 – 2015), clearly demonstrated that survival rates can increase when appropriate resources are mobilised. The next phase is the Sustainable Development Goals (2016 – 2030) which have been endorsed by over 150 world leaders and represent an ambitious approach to health, particularly the third Goal: “Ensure healthy lives and promote well-being for all at all ages”. With the value of human milk for the preterm infant population in mind, it is time to act, to offer these infants the opportunity to not only survive, but to thrive.

Improving breastfeeding and human milk feeding

Many different interventions aimed at improving breastfeeding and human milk feeding for preterm infants have been suggested. These range from hospital-based education programmes to government policy adaptations. The following list describes some of these concepts:

- Providing adequate and timely lactation support to mothers of preterm infants, including access to equipment, an appropriate space for breast expression and other amenities in the NICU
- Educating families of preterm infants on the benefits of human milk so that they can make an informed choice about feeding human milk to their infant
- Promoting own mother's milk as an evidence-based medical intervention and one of the most powerful things that only a mother can do as part of the care of her preterm infant
- Empowering parents through NICU peer support programmes
- Implementing NICU policies that offer facilities for mothers to access their infant 24/7 and encourage skin-to-skin contact and breastfeeding whenever possible
- Setting up interdisciplinary diagnostic and lactation treatment paths for mothers, and ensuring all staff involved in the care of the NICU infant have at least a basic level of lactation education in order to deliver consistent messages to families
- Developing standardised, evidence-based best practices to effectively and hygienically handle the logistics of expressing, collecting, labelling, storing and feeding human milk
- Advocating for a sufficient maternity leave for mothers of preterm infants to support their availability for breastfeeding, or at least a dedicated location in the workplace for breast expression
- Encouraging health insurers to support, educate and offer incentives for mothers to provide human milk to their preterm infant

When there is not enough of an infant's own mother's milk:

- Creating and implementing a national regulatory pathway to open and finance milk banks to ensure exclusive human milk feeding
- Promoting and valuing human milk donation to milk banks, in a similar way to blood donation, for the good of society as a whole

These are just a few examples of the vast range of strategies that exist globally. Each initiative needs to be assessed for its appropriateness in the context of local practices and cultures. Further research and appropriate, standardised metrics are needed in order to continue to build on the current understanding of the effectiveness of these interventions in varied settings.

This health economics assessment of the value of human milk offers a sound basis for justifying a financial investment into such human milk initiatives. It can support the calculation of standard financial indicators such as returns on investments, net present values, break-even points as well as net profits from the investments, thus encouraging decision makers to take the next steps towards supporting a human milk diet for preterm infants.

About this brochure

This brochure was developed in cooperation with York Health Economics Consortium of the University of York, UK, that carried out an independent assessment of the health economic value of human milk in preterm infants for Medela. The sources used were checked for the currentness, quality and robustness of their data. The improvements in health outcomes resulting from human milk were derived from high quality scientific publications and systematic reviews. Use was made principally of UK or England-specific data, e.g. from NICE and the Hospital Episode Statistics (HES), as well as German data, e.g. from governmental health reports (GBE), Diagnosis Related Group (DRG) reimbursement, Statista, Eurostat to translate these improvements into economic cost savings, gained QALYs and retained productivity. Where no data was available to complete the assessment, YHEC made conservative estimates on the basis of their experience or modelled them from related data sources. The cost data from all sources older than 2014 was inflated to that year. To obtain a realistic picture independent of the age at which a disease and its costs occur, the costs and QALYs were discounted to the birth year at an annual rate of 3.5 % (following NICE guidelines).

THE UNIVERSITY of York

YHEC
York Health Economics Consortium

Definitions

Exclusive breastfeeding/human milk feeding: WHO recommends exclusive human milk diet for the first 6 months in life. Appropriate complementary foods can then be introduced while breastfeeding/human milk feeding continues for up to two years and beyond.

Human milk feeding: The model defines this as direct breastfeeding or the feeding of milk expressed from the mother or a donor and may contain fortification. Only exclusively human milk fed infants were included in the model.

Formula feeding: The model defines this as liquid or powdered cow milk based substances used instead of human milk. Only exclusively formula-fed infants were included in the model.

Fortification: Enrichment of human milk with specific nutrients in a predefined composition (e.g. fat, lipids, proteins, iron, vitamins).

Species-specific: Human milk is tailored to human infants in its components and their composition.

Milk types according to their feeding priority: Fresh own mother's milk, frozen own mother's milk, fresh raw donor milk, pasteurised donor milk, formula.

Discounting: An investment in something that provides returns in the future must prove to be more profitable than the risk-free interest rate. The expected future return on this investment is consequently reduced by the annual risk-free rate for each year that this return lies in the future. These reductions can be substantial. All financial benefits (returns) from human milk lying in the future (QALYs, reductions in long-term complications, lifetime earnings) are discounted by 3.5 % to the first year of life when breastfeeding (and the investment) takes place.

Inflating costs: Where relevant, costs are inflated to 2014 prices following the UK Hospital and Community Health Services Index. This means that reference costs that are calculated too far in the past are increased by the annual inflation rates until the year 2014.

Preterm infant populations: To derive the total costs/cost savings, the preterm infant populations of England / Wales (51 703) and Germany (58 627) [54] were used as examples.

Quality Adjusted Life Years, QALYs: Are a measure of the health outcomes resulting from a particular treatment or intervention in the form of an expected utility gain (or loss). QALYs provide a common metric that enables comparisons to be made between interventions involving qualitatively varying health outcomes.

Limitations to the model

To derive the health outcomes of human milk and formula-fed infants, only data on the infants fed exclusively one or the other were compared. Those infants on a mixed diet can be expected to be in between these two end points.

In the studies and systematic reviews used for human milk fed infants there is variability in terms of duration of exclusive human milk feeding ranging from “at hospital discharge”, 4 weeks and up to 6 months.

Due to the lack of appropriate data, no differentiation was made between own mother’s milk and pasteurised or raw donor milk. Whenever possible fresh own mother’s milk should be prioritised over other forms of human milk and formula [56].

For this brochure and the underlying model, no differentiation was made between the methods of how human milk or formula were fed (cup, enteral, breastfeeding, bottle, etc.).

Due to the stringent inclusion criteria for the evidence used, the effect of human milk on some morbidities might be underestimated. With the publication of further high quality research, this might change in the future.

Additionally, this model only considers costs that develop among the preterm population. This does not include, for example, psychological care of family members in case of death, potential absence of the mother from work, or the higher incidence rate of breast and ovarian cancer in mothers who do not breastfeed.

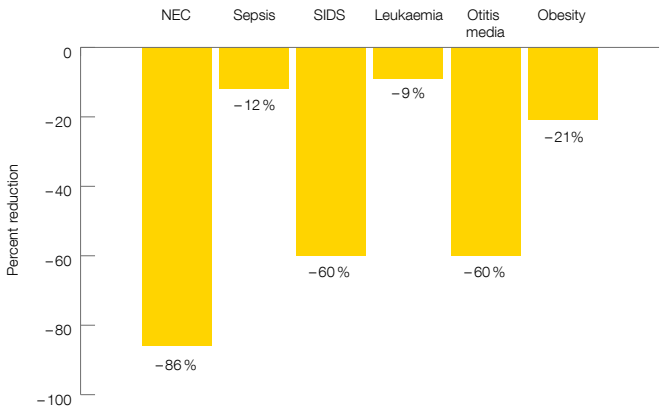
Appendix

	England and Wales		Germany	Average
Perterm births (2013)	51 703		58 627	
Short-term cost savings				
NEC costs per case	22 432.20 €	(17 138.20 £)	23 200.42 €	22 816.31 €
Sepsis costs per case	4 865.81 €	(3 717.48 £)	9 121.19 €	6 993.50 €
Total short-term costs per preterm infant	763.63 €	(583.41 £)	796.70 €	780.16 €
Total short-term costs entire population	39 481 737.21 €	(30 163 771.31 £)	46 708 035.82 €	
Long-term cost savings				
Leukaemia per case	149 811.94 €	(114 456.32 £)	123 069.46 €	136 440.70 €
Acute otitis media per case	60.21 €	(46.00 £)	1 381.10 €	720.65 €
Mild disability per case	14 421.00 €	(14 421.00 £)	21 509.47 €	17 965.24 €
Moderate disability per case	13 959.00 €	(13 959.00 £)	20 820.38 €	17 389.69 €
Severe disability per case	365 005.00 €	(365 005.00 £)	544 418.96 €	454 711.98 €
Diabetes per case	2 130.89 €	(1 628.00 £)	11 287.00 €	6 708.95 €
Coronary heart disease per case	2 100.79 €	(1 605.00 £)	11 645.00 €	6 872.89 €
Total long-term costs per preterm infant	431.70 €	(312.90 £)	721.07 €	576.38 €
Total long-term costs entire population	22 319 947.81 €	(17 052 440.13 £)	42 273 913.07 €	
Total direct cost savings per infant	1 195.32 €	(913.23 £)	1 517.76 €	1 356.54 €
Total direct cost savings entire population	61 801 685.02 €	(47 216 211.43 £)	88 981 948.89 €	
Productivity gains				
Productivity loss per infant	3 886.52 €	(2 969.30 £)	2 963.65 €	3425.08 €
Productivity loss entire population	200 944 656.94 €	(153 521 717.90 £)	173 749 640.38 €	
Retained quality of life				
Quality adjusted life years (QALYs) retained	0.205		0.217	0.211
Economic value QALY per preterm infant	5 363.87 €	(4 098.00 £)	N/A*	N/A*
Economic value QALY entire population	277 328 395.29 €	(211 878 894.00 £)	N/A*	N/A*
Exchange rate: 1£ = 0.76 € (05.06.2016)				

* Method of translating QALYs in monetary or investment value does not exist in Germany

Fact sheet: The health and economic benefits of feeding human milk to preterm infants

- One of every 10 infants is born preterm. Prematurity is the leading cause of death under the age of five, and is associated with devastating diseases, not only during the acute hospital phase, but often throughout the entire lifespan [1, 2].
- Human milk consists of thousands of unique components. These interact synergistically to reduce the incidence, severity, and risk of debilitating morbidities in preterm infants [3–7].
- By significantly improving short and long-term outcomes, human milk provides an extraordinary economic value to all healthcare stakeholders.
- The York Health Economics Consortium (YHEC), University of York, developed a health economic model to demonstrate the value of feeding a preterm infant an exclusive human milk diet in terms of treatment costs, productivity, and quality of life, compared to an exclusive formula diet [8].

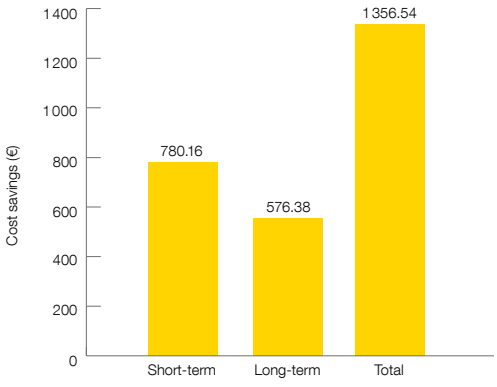


Risk reduction in preterm infants for specific complications through exclusive human milk feeding, compared to formula feeding [8].

Health benefits

Preterm infants fed an exclusive human milk diet experience substantial health improvements in comparison to those who receive formula instead. Numerous studies show significant reductions in morbidities, not only in the first year, but also later in life [3–5, 8–11].

Human milk significantly improves health outcomes in preterm infants



Average healthcare cost savings per preterm infant through exclusive human milk feeding [8, 12–14].

Economic impact

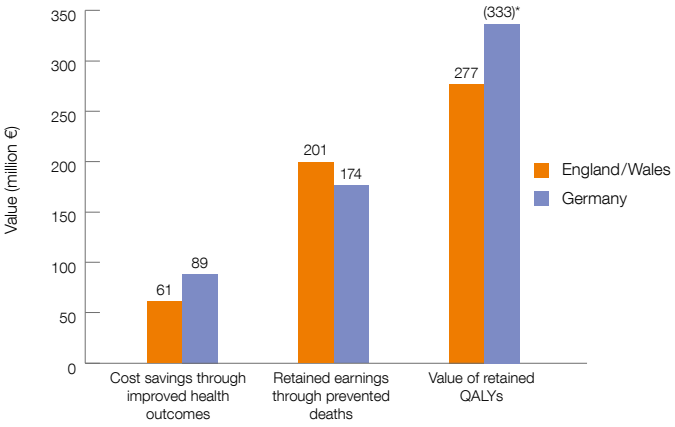
Direct short and long-term cost savings

By preventing multiple morbidities, over the course of a lifetime, an exclusive human milk diet saves an average of 1 356.54 € per preterm infant in direct healthcare costs. Over 41 % of these cost savings occur long after hospital discharge, due to a reduction in leukaemia, otitis media, coronary heart disease, diabetes, and long-term disabilities [5, 8–11].

The long-term economic benefits are as substantial as those during the acute care stage

Increased productivity

By reducing NEC, sepsis and SIDS, a human milk diet also reduces mortality rates [8]. This produces, on average, additional lifetime earnings of 3 425 € [8, 15] per preterm infant. The gained earnings benefit the productivity and wealth of a society via increased contributions to tax, social and health insurance systems [8].



The annual health economic potential of feeding human milk to all preterm infants in England/Wales and Germany [8, 13, 14].

*Monetary evaluation of QALYs is not universally accepted in Germany.

A deficit in human milk for preterm infants decreases the productivity and weakens the economic power of the entire society

Improved quality of life

For every 1 000 preterm infants exclusively fed human milk instead of formula, 211 [8] quality adjusted life years (QALYs) are gained. QALYs assess the effectiveness of an intervention in terms of quality-of-life units gained relative to no treatment or alternative treatments. In the UK for example*, such an improvement justifies investments of up to 5 364 € [8] in human milk provision and breastfeeding support for each preterm infant [8].

The entire nation benefits from human milk

The unique properties of human milk make it both a medical intervention and a measure to prevent numerous short and long-term complications. It simultaneously improves the health outcomes of preterm infants and the economic outcomes of all healthcare stakeholders. By facilitating breastfeeding and providing human milk to preterm infants, hundreds of millions of Euros can be saved every year by hospitals, insurers, governments and the society.

Interventions to promote and support breastfeeding and human milk feeding

While the entire healthcare system and the society benefit from human milk, during the critical first months after birth, only mothers and hospitals can provide this medical intervention. It is therefore in every healthcare stakeholder's interest to invest in supporting mothers, hospitals and healthcare professionals to provide an exclusive human milk diet to all preterm infants. Numerous interventions at various levels have been shown to improve human milk feeding rates: up-to-date breastfeeding and lactation equipment and education for mothers and hospital staff, reimbursement or incentives for breastfeeding, extended maternity leave, as well as institutionalisation and control of respective care standards [16, 17].

Investments into human milk interventions will improve the health outcomes of preterm infants and return a high economic value to all healthcare stakeholders

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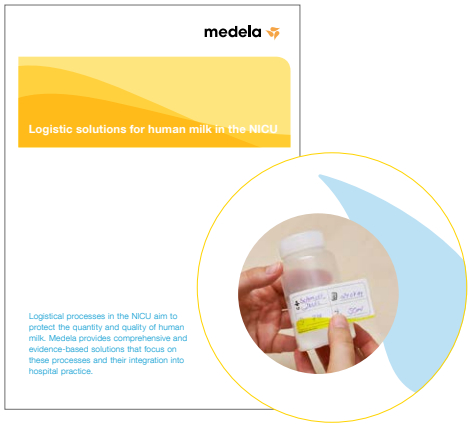
Human milk solutions for preterm infants

Medela provides dedicated products and detailed knowledge on the most challenging areas in the neonatal intensive care unit like the logistical processes of human milk and breastfeeding, the safe handling and infection control of human milk as well as the development of breastfeeding skills in preterm infants.



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